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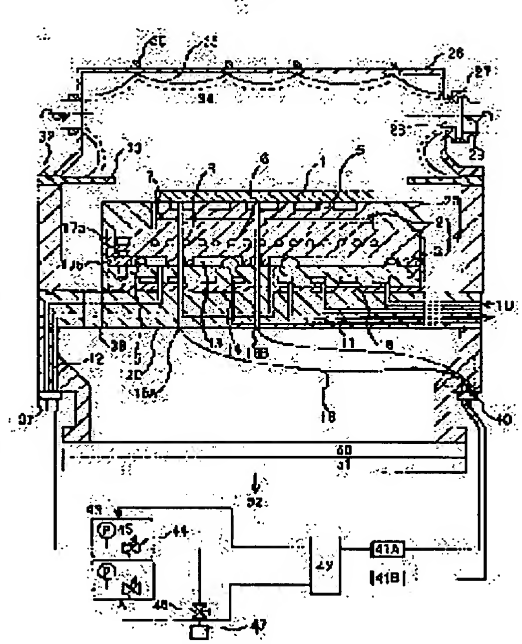
(54) PROCESSING DEVICE FOR SAMPLE AND PROCESSING METHOD THEREFOR

(57)Abstract:



PROBLEM TO BE SOLVED: To solve a problem that input heat which changes with time cannot be extracted with good responsiveness and a wafer temperature cannot kept to be constant at the heating time of heater or plasma heating in conventional technology, that temperature distribution in a wafer face is remarkably deteriorated at the time of processing the wafer at the high temperature, or the plasma processing of good quality is impossible since the heating-up temperature of the wafer cannot be made to be sufficiently high.

SOLUTION: In the processing device of a sample, which plasma-processes the sample, while the temperature of the sample kept by an adsorbing device is controlled, the adsorbing device has a holding member for holding the sample and a cooling member cooling the sample. A recessed part for forming a first heat transmission gas chamber part between the cooling member and the holding member is installed in the cooling member. A recessed part for forming a second heat transmission gas chamber part between the holding member and the sample in a state where the sample is kept is installed. The first or second heat transmission gas chamber part is constituted of a plurality of heat transmission gas chambers that can independently be pressure-controlled.

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JAPANESE [JP,2002-009064,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

CLAIMS

[Claim(s)]

[Claim 1] It is the processor of the sample characterized by having two or more heat transfer gas chambers where said adsorber was classified in the processor of the sample which carries out plasma treatment of this sample corresponding to the core and the periphery section of said sample, controlling the temperature of the sample held at the adsorber, and having a means to control the pressure of each heat transfer gas chamber independently according to the temperature of said sample.

[Claim 2] The processor of the sample characterized by having a means to maintain and process the temperature of the core of said sample, and the periphery section in the processor of the sample which carries out plasma treatment of this sample from 500**50 degrees C to 700**50 degrees C at the time of plasma treatment, controlling the temperature of the sample held at the adsorber.

[Claim 3] It is the processor of the sample characterized by having an attachment component for said adsorber holding a sample in the processor of the sample which carries out plasma treatment of this sample, controlling the temperature of the sample held at the adsorber, and the cooling member which cools a sample through this attachment component, and forming independently two or more heat transfer gas chambers in which pressure control is possible between said attachment components and said cooling members.

[Claim 4] It is the processor of the sample characterized by to establish the crevice for forming independently two or more heat-transfer gas chambers in which pressure control is possible between said attachment components and said samples where it has an attachment component for said adsorber to hold a sample in the processor of the sample which carries out plasma treatment of this sample, controlling the temperature of the sample held at the adsorber, and the cooling member to cool and said sample is held in said attachment component.

[Claim 5] In the processor of the sample which carries out plasma treatment of this sample, controlling the temperature of the sample held at the adsorber said adsorber Have an attachment component for holding a sample, and the cooling member to cool, and the crevice for forming the 1st heat transfer gas chamber portion in said cooling member between this cooling member and said attachment component is prepared. The crevice for forming the 2nd heat transfer gas chamber portion between said attachment component in the condition that said sample was held, and said sample is established in said attachment component. The processor of the sample characterized by constituting independently either of the said 1st and 2nd heat transfer gas chamber portion from two or more heat transfer gas chambers in which pressure control is possible.

[Claim 6] It is the processor of the sample characterized by performing pressure control of each ** of said radial inside and outside so that it may have at least two ** in which said two or more heat transfer gas chambers were established in claim 3 thru/or either of 5 corresponding to the core and the periphery section of said sample and this heat deformation may be pressed down according to the heat deformation pattern of said attaching part.

[Claim 7] The processor of the sample characterized by having a thermometer for measuring the temperature on said rear face of a sample in claims 1 and 3 thru/or either of 6 in two or more

locations corresponding to said two or more heat transfer gas chambers, feeding back this temperature value, and controlling the controlling factor of said sample temperature.
[Claim 8] The processor of the sample characterized by for the processor of said sample processing a sample at an elevated temperature, having a heater in said attachment component in claim 1 thru/or either of 6, having the passage of a cooling medium in said cooling member, and using a heat-resistant elastic body for said two or more separation between gas chambers.
[Claim 9] The processor of the sample characterized by controlling the pressure of the heat transfer gas between a sample and said attachment component, said heat transfer gas pressure between an attachment component and said cooling member, the amount of heater heating, the temperature of a cooling medium, and a flow rate for every each part grade as said controlling factor in claim 8.
[Claim 10] The processor of the sample characterized by fixing said attachment component and said cooling member through an insulating material in between in claim 8.
[Claim 11] The processor of the sample characterized by maintaining and processing the temperature at the time of processing in the core and the periphery section of said sample in claim 7 from 500**50 degrees C to 700**50 degrees C.
[Claim 12] It is the art of the sample characterized by having two or more heat transfer gas chambers where said adsorber was classified in the art of the sample which carries out plasma treatment of this sample corresponding to the core and the periphery section of said sample, controlling the temperature of the sample held at the adsorber, controlling independently the pressure of two or more of said heat transfer gas chambers according to the temperature of said sample, and carrying out plasma treatment of said sample.
[Claim 13] The art of the sample characterized by maintaining and processing the temperature of the core of said sample, and the periphery section in the art of the sample which carries out plasma treatment of this sample from 500**50 degrees C to 700**50 degrees C at the time of plasma treatment, controlling the temperature of the sample held at the adsorber.
[Claim 14] In the art of the sample which carries out plasma treatment of this sample, controlling the temperature of the sample held at the adsorber which has an attachment component and a cooling member Have the 1st heat transfer gas chamber portion between said cooling members and said attachment components, and it has the 2nd heat transfer gas chamber portion between said attachment components and said samples. At least one of said 1st heat transfer gas chamber portion and said the 2nd heat transfer gas chamber portion The processor of the sample characterized by consisting of two or more heat transfer gas chambers classified into the core and the periphery section of a sample, controlling independently the pressure of two or more of said heat transfer gas chambers, and maintaining and processing the temperature at the time of processing in the core and the periphery section of said sample from 500**50 degrees C to 700**50 degrees C.
[Claim 15] The process which carries in a sample to a processing room by conveyance systems, such as a vacuum robot, and the process which carries said sample in the attachment component containing the heater and adsorption electrode of said processing interior of a room, The process which adsorbs said sample at said attachment component, and the process heated at the heater in said attachment component, The process which controls a pressure and supplies gas between said samples and said attachment components, The process which controls a pressure and supplies gas between the cooling member which has cooling passage, and said attachment component, The art of the sample characterized by including the process which controls temperature and a flow rate to said cooling member, and supplies a cooling medium, the process which makes said processing interior of a room generate the plasma, the process which carries out desorption of said sample from said attachment component, and the process which takes out said sample from said processing room.
[Claim 16] In the art of the sample which carries out plasma treatment of this sample, controlling the temperature of the sample held at the adsorber which has an attachment component and a cooling member Have the 1st heat transfer gas chamber portion between said cooling members and said attachment components, and it has the 2nd heat transfer gas chamber portion between said attachment components and said samples. The process which consists of heat transfer gas

chambers of plurality at least one of said 1st heat transfer gas chamber portion and said 2nd heat transfer gas chamber portion, and surveys temperature of the rear face of said sample in two or more places, a core, the periphery section, etc., The gas pressure for every gas chamber of the process which detects the difference between the actual measurement of this temperature, and the set point, said 1st heat transfer gas chamber, and said 2nd heat transfer gas chamber, the amount of heating of a heater, the flow rate of a cooling medium, the art of the sample characterized by including the process which controls at least one of the temperature.
[Claim 17] In the art of the sample which carries out plasma treatment of this sample, controlling the temperature of the sample held at the adsorber which has an attachment component and a cooling member Have the 1st heat transfer gas chamber portion between said cooling members and said attachment components, and it has the 2nd heat transfer gas chamber portion between said attachment components and said samples. It consists of heat transfer gas chambers of plurality at least one of said 1st heat transfer gas chamber portion and said 2nd heat transfer gas chamber portion. Said two or more heat transfer gas chambers The art of the sample characterized by performing pressure control of each ** of said core and periphery section so that it may have at least two ** prepared corresponding to the core and the periphery section of said sample and this heat deformation may be pressed down according to the heat deformation pattern of said attaching part.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the processor of samples, such as a wafer, and the art of a sample, and relates to semiconductor fabrication machines and equipment, such as a CVD system which carries the art of a sample and this by the high temperature form adsorber especially used for semiconductor fabrication machines and equipment, such as a CVD system, and this high temperature form adsorber. Of course, this invention is applicable to liquid crystal plasma treatment equipment, a sputtering system, etc.
[0002]
[Description of the Prior Art] Although HDP-CVD with few film degradation after processing and the numbers of processes (high density plasma CVD) attracts attention about the semi-conductor processor as compared with the conventional approaches (TEOS-O3 CVD etc.) in detailed-izing in recent years and the interlayer insulation film embedding of a high aspect ratio, in this HDP-CVD, the thermal oxidation film and equivalent level are demanded by the user as membraneous quality of this interlayer insulation film.
[0003] The relation between substrate temperature and membraneous quality (etching velocity ratio of the thermal oxidation film) is shown in drawing 16 . In order to obtain the membraneous quality more nearly same than this drawing as the thermal oxidation film, it turns out that substrate temperature must be raised to an about 600-degree C elevated temperature. Moreover, it is necessary to make temperature distribution into temperature-distribution within the limits needed from membraneous distribution in a wafer side.
[0004] To the above-mentioned demand, the approach actually performed conventionally carries out near the high vacuum, carries out the heat insulation of the helium pressure between an electrostatic chuck and a wafer, and carries out a temperature up. However, there is heat recess by heat conduction etc. in the heat recess by the thermal radiation to a perimeter, and the contact section with other members, temperature cannot fully be raised by this approach, and there is a trouble that temperature distribution deteriorate remarkably, at the time of a hot temperature up.
[0005] Here, the outline structure and the trouble of the conventional technique for controlling wafer skin temperature are described.
[0006] First, the structure of having the combination of the fiber made from heat-resisting material or the mediation layer of foam between the semi-conductor wafer attachment component which embedded the heater at the nitride-ceramics base material, and a metal cooling system is indicated by JP,9-17849,A.
[0007] Moreover, what has a heater and cooling piping in a high temperature form adsorber on a wafer stage is indicated by JP,10-64985,A. That is, if it has a heater in an attachment component and the temperature up of the attachment component is carried out now, the structure which unifies the cooling section which carries out cooling of the part for the heat input from the plasma to coincidence is indicated.
[0008] A thing given in above-mentioned JP,9-17849,A has the following trouble, and it is thought that temperature control cannot be carried out to constant-temperature within the

limits at the time of a plasma heat input.
(1) Although it is the structure of applying a pressure to cooling for a heat input from the plasma which changes by time amount at the above-mentioned mediation layer, and adjusting the amount of heat transfers between an attachment component and a cooling system, it is quite difficult to actually correspond to the plasma heat gain which changes every moment, and to change the pressure of inclusion.
(2) When it becomes the high-power consistency by which the power density on a wafer side like HDP-CVD attains to 10 W/Cm2, it is actually quite difficult to perform cooling enough with structure which applies and carries out cooling of the pressure to the above mediation layers.
[0009] Next, a thing given in JP,10-64985,A is considered that wafer skin temperature is uncontrollable to constant-temperature within the limits by the following trouble the same way at the time of a plasma heat input.
[0010] (1) When making wafer processing temperature into hundreds of degrees C, even if the wall surface of cooling piping is the case where a big temperature gradient is given by metal JAKKETTO, it will exceed about 200 degrees C, for example. It does not evaporate at such an elevated temperature, either, but it is cheap and, as for the cooling-medium kind which can be used for insurance at semiconductor fabrication machines and equipment, a number is restricted considerably.
(2) Although there is the need of enlarging heat transfer area enough since the sufficiently large heat transfer coefficient in a wall surface cannot be taken to fully carry out cooling when the heat input power density to a wafer reaches about two 10 W/Cm big power density like HDP-CVD with the above-mentioned cooling medium, there is a problem which cannot take the cooling effect enough from a limit of the area of a cooling jacket actually.
(3) When carrying out heating at high temperature of the electrostatic chuck, in order to suppress heat deformation of the electrostatic chuck itself within an allowed value, there is the need of giving rigidity enough to a metal jacket, and it is necessary to manufacture thickness sufficiently greatly. For this reason, there are troubles -- the electrostatic chuck itself becomes heavy and maintenance nature worsens.
(4) under the plasma treatment from which a heat gain is alike every moment, and changes -- setting -- the increment in a heat input, and a decrement -- responding -- When ******(ing) or cooling, since the heat capacity of an electrostatic adsorber is large, responsibility is good, and in order to carry out temperature within a certain fixed limits, the refrigeration unit which has the heater or refrigeration capacity which has quite big heating capacity is required, and is not realistic.
[0011] That by which the space for introducing gas also between an electrode and a sample base was established in Fig. 7 of JP,2-135753,A on the other hand while the space for introducing gas was formed between the sample and the electrode is indicated.
[0012] The thing of a publication also has the same trouble as the above in this official report, and it is thought that temperature control cannot be carried out to constant-temperature within the limits at the time of a plasma heat input.
[0013]
[Problem(s) to be Solved by the Invention] Although the trouble of the conventional technique is as having described above, the following of the main point is carried out.
(1) the heat gain which changes every moment at the time of heater heating and a plasma heat input -- corresponding -- between an attachment component and a cooling system -- the amount of heat transfers cannot be changed with responsibility sufficient enough, and the homogeneity of skin temperature distribution of a wafer deteriorates.
(2) When whenever [stoving temperature / of a wafer attachment component] exceeds about 300 degrees C, since there is no **, the wall surface of a cooling member exceeds 200 degrees C by giving a sufficiently big temperature gradient to an attachment component and a cooling member. There are quite few cooling-medium kinds which can obtain insurance and cheap and sufficient cooling engine performance on such conditions.
(3) In the case where wafer processing temperature exceeds about 300 degrees C, when there is a big heat input from which power density like HDP-CVD becomes about two 10 W/Cm, it

cannot have refrigeration capacity sufficient with the cooling medium which can be used, but the homogeneity of skin temperature distribution of a wafer deteriorates.
(4) Although it is necessary to enlarge rigidity for the cooling section enough in order to suppress heat deformation of an electrostatic chuck in an allowed value, a cooling plate becomes heavy by this and there is a problem on which maintenance nature deteriorates remarkably.
(5) Since the heat capacity of an electrostatic adsorber is large, corresponding to the plasma heat input which changes every moment, responsibility is good, the refrigeration unit which has quite big heater or refrigeration capacity for controlling temperature of an electrostatic adsorber is required for a certain temperature requirement, and it becomes enlargement of equipment, and a cost rise.
[0014] This invention cancels the temperature heterogeneity on the front face of a sample which produces homogeneous degradation of membraneous quality in consideration of each above-mentioned matter, and aims at offering the good homogeneous high processed sample of membraneous quality.
[0015]
[Means for Solving the Problem] In the processor of the sample which carries out plasma treatment of this sample, said adsorber is characterized by to have two or more heat transfer gas chambers classified corresponding to the core and the periphery section of said sample, and to have a means to control the pressure of each heat transfer gas chamber independently according to the temperature of said sample, this invention controlling the temperature of the sample held at the adsorber in order to solve the above-mentioned technical problem.
[0016] Other descriptions of this invention are in the processor of the sample which carries out plasma treatment of this sample to have had a means to maintain and process the temperature of the core of said sample, and the periphery section from 500**50 degrees C to 700**50 degrees C at the time of plasma treatment, controlling the temperature of the sample held at the adsorber.
[0017] Controlling the temperature of the sample held at the adsorber, in the processor of the sample which carries out plasma treatment of this sample, said adsorber has an attachment component for holding a sample, and the cooling member which cools a sample through this attachment component, and other descriptions of this invention are to have formed independently two or more heat transfer gas chambers in which pressure control is possible between said attachment components and said cooling members.
[0018] Said adsorber has an attachment component for holding a sample, and the cooling member to cool, and other descriptions of this invention are in the processor of the sample which carries out plasma treatment of this sample to have established the crevice for forming independently two or more heat-transfer gas chambers in which pressure control is possible between said attachment components and said samples, where said sample is held in said attachment component, controlling the temperature of the sample held at the adsorber.
[0019] In the processor of the sample other descriptions of this invention carry out plasma treatment of this sample, controlling the temperature of the sample held at the adsorber said adsorber Have an attachment component for holding a sample, and the cooling member to cool, and the crevice for forming the 1st heat transfer gas chamber portion in said cooling member between this cooling member and said attachment component is prepared. The crevice for forming the 2nd heat transfer gas chamber portion between said attachment component in the condition that said sample was held, and said sample is established in said attachment component, and it is in having constituted independently either of the said 1st and 2nd heat transfer gas chamber portion from two or more heat transfer gas chambers in which pressure control is possible.
[0020] Said two or more heat transfer gas chambers have at least two ** prepared corresponding to the core and the periphery section of said sample, and other descriptions of this invention are to perform pressure control of each ** of said radial inside and outside according to the heat deformation pattern of said attaching part, so that this heat deformation may be pressed down.
[0021] Said adsorber is in the art of the sample which carries out plasma treatment of this

sample to have two or more heat transfer gas chambers classified corresponding to the core and the periphery section of said sample, control independently the pressure of two or more of said heat transfer gas chambers according to the temperature of said sample, and carry out plasma treatment of said sample, other descriptions of this invention controlling the temperature of the sample held at the adsorber.
[0022] According to this invention, it becomes possible to maintain the homogeneity of temperature distribution and to carry out plasma treatment of the sample at an elevated temperature, and a quality processed sample can be offered.
[0023] It is as follows when the more concrete descriptions of this invention are enumerated.
(1) The heat transfer gas chamber was prepared between the attachment component, wafer flesh-side face-to-face and an attachment component, and the cooling member. Moreover, the gas chamber was divided into two or more parts. For example, it separated into two places like a wafer core and the periphery section.
(2) The elastic bodies (for example, Viton O ring etc.) which have thermal resistance were used between the attachment component and the cooling member for the above-mentioned gas chamber separation. Moreover, in consideration of the heat deformation at the time of heating of the attachment component containing the electrostatic chuck which built in the heater, in consideration of the size of the sealant which can hold a seal, it considered as the channel depth and O ring maintenance structure of an O ring so that after heat deformation could maintain helium gas pressure.
(3) The thermometer for measuring the temperature on the rear face of a wafer for every each part grade has been arranged, the difference between a wafer thermometry value and desired value was detected, and it controlled independently using the controller which controls a controlling factor.
(4) As the above-mentioned controlling factor, helium gas pressure between a wafer rear face and an attachment component front face and between an attachment component and a cooling member, the amount of heater heating, the temperature of a cooling medium, and a flow rate were changed.
(5) In order to control heat recess, the heat insulating material has been arranged to the contact surface of an attachment component and a cooling member.
(6) In order to make small the touch area of the above and a heat insulating material, it was lightweight and honeycomb structure with reinforcement etc. was used.
[0024] (1) According to this invention, it becomes possible by adopting the above-mentioned description (1) to change freely the heat transfer coefficient between an attachment component and a cooling member with sufficient responsibility with the pressure of heat transfer gas, and to acquire the about one heat transfer effectiveness for a divisor of compulsion water cooling from a full heat insulation condition by that of ****.
(2) Since a heat transfer gas chamber is separable for every each part grade which is degrading the temperature homogeneity on a wafer side by adopting the above-mentioned description (1), temperature control becomes possible independently for every each part grade, and it becomes possible to raise the temperature homogeneity of a wafer.
(3) Since the gas leak between the heat transfer gas chambers by heat deformation of a wafer attaching part can be prevented and a heat transfer gas chamber can be separated by using a heat-resistant elastic body for separation of a heat transfer gas chamber by adopting the above-mentioned description (2), temperature control becomes possible independently for every each part grade, and it becomes possible to raise the temperature homogeneity of a wafer.
(4) By adopting the above-mentioned description (3), it is feed so that the temperature may be measured for every each part grade and it may become desired value. Since it can back, wafer skin temperature distribution can be equalized for every each part grade.
(5) By adopting the above-mentioned description (4), it becomes possible by controlling at least one controlling factor of helium gas pressure between a wafer rear face and an attachment component front face and between an attachment component and a cooling member, the amount of heater heating, the temperature of a cooling medium, and a flow rate to raise the temperature homogeneity of a wafer.

(6) By adopting the above-mentioned description (5), it becomes possible to prevent the heat recess produced in the contact surface between an attachment component and a cooling member, and to raise the temperature homogeneity of a wafer.
(7) By adopting the above-mentioned description (6), it becomes possible to prevent the heat recess in the contact surface between an attachment component and a cooling member, and to raise the temperature homogeneity of a wafer.
[0025] In addition, this invention is not only wafers, such as a semi-conductor, but a liquid crystal manufacturing installation, a plasma etching system, and a spatter. ** It is applicable to ** etc.
[0026]
[Embodiment of the Invention] Hereafter, the example of this invention is explained. Drawing 1 is the schematic diagram of the plasma treatment equipment in which the 1st example of this invention is shown, and drawing 2 is each top view of an attachment component and a cooling member in the example of drawing 1 . Hereafter, plasma-CVD equipment is made into an example and explained. Plasma-CVD equipment is equipped with the reaction chamber 26, mu wave waveguide 27 which introduces the mu wave 29 in this reaction chamber 26, the permanent magnet 30 arranged around mu wave transparency aperture 28, and the nozzle 33 which supplies raw gas in a reaction chamber 26. Moreover, it has the high temperature form electrostatic chuck 4 formed by the attachment component 2 and the cooling member 3. Electrostatic adsorption of the processing object of a sample, i.e., wafer 1 grade, is carried out by the high temperature form electrostatic chuck 4 at the time of processing.
[0027] As for the electrostatic chuck member 5, the irregularity of hundreds of micrometers is processed into irregularity from 10 micrometers of height numbers in the front face by the side of a wafer side. As shown in drawing 2 , annular soil hand part 2D was formed in the periphery edge of the electrostatic chuck member 5, and the amount of helium gas leaks from the periphery side is restricted. Moreover, by two inside soil hand parts, an electrostatic chuck front face is divided into three places (2A-2C), and the slit of small width of face is prepared in each soil hand part.
[0028] Inside the attachment component 2, two adsorption electrodes 7 for forward and negative are included. The electrical potential difference of positive/negative is impressed to the adsorption electrode 7 by the direct-current bias power supply which is not illustrated. The electrostatic chuck section support plate 6 contains the heater 8, and carries out the temperature up of the electrostatic chuck member 5 to constant temperature into fixed time amount. The electrostatic chuck member 5 and the electrostatic chuck section support plate 6 curse In etc., or are joined by metal junction etc. Technique, like in order that the electrostatic chuck member 5 and the electrostatic chuck section support plate 6 may control the heat deformation at the time of heating, they double a coefficient of thermal expansion by a certain within the limits, or sandwich an inclination ingredient in between may be taken.
[0029] In the interior of the cooling member 3, the cooling passage 11 for cooling-medium 10 and the passage 12 for helium gas are located.
[0030] In the top face of the cooling member 3, i.e., the field by the side of an attachment component 2, as shown in drawing 2 , two space 13A and 13B for heat transfer gas chambers is established, and the elastic body (for example, Viton O ring) 14 with high thermal resistance is used for a partition of each space 13A and 13B for heat transfer gas chambers. Moreover, O ring 15 is arranged in the periphery section of the cooling member 3, propagation and the amount of heliums to leak are lost for the clearance between an attachment component 2 and the cooling member 3, and the homogeneity of wafer temperature is raised. Although the top face of the cooling member 3 is [only being divided within and without / two / radial, and] in the example of drawing 1 and drawing 2 , it is also possible to separate and form the space for heat transfer gas chambers in several places. A gas chamber 13 is formed of these space for heat transfer gas chambers and inferior surfaces of tongue of an attachment component 2. It is more advantageous to carry out separation formation of the heat transfer gas chamber 13 at plurality, in order to raise the homogeneity of temperature distribution more. Moreover, in what has the large path of a sample, or it divides radial into three places, in addition to radial, it may divide

also into a circumferencial direction at plurality, and two or more heat transfer gas chambers in which pressure control is possible may be prepared.
[0031] On both sides of insulating material 17a and b, it fixes with a screw etc. for the heat insulation of an attachment component 2 and the cooling member 3. The insulating material 18 is inserted for the insulation with the high temperature form electrostatic chuck 4 and the support plate 20 for high temperature form electrostatic chucks. This is used for a high frequency insulation when high frequency is impressed to the high temperature form electrostatic chuck 4, and in case high frequency is impressed to RF electrode which is not illustrated to an electrostatic chuck member, and ingredients, such as Teflon (trademark) and an alumina, are used.
[0032] 16 is a fiber-optic thermometer probe and measures the temperature on the rear face of a wafer wafer. The path of the heat transfer gas supplied to the space of the space 2A-2C on the rear face of a wafer wafer using the hole of this probe part may be formed. Moreover, the path of a wafer rise-and-fall pin may be formed. In the metal side of the high temperature form electrostatic chuck 4, covering 25 is arranged so that the metal contamination by the spatter may not be generated.
[0033] The following of the reason which divided the above-mentioned heat transfer gas chamber 13 into two or more parts by this invention is carried out. helium gas pressure and heat transfer charge of the gas interior of a room The relation of Number alpha comes to be shown in drawing 3 , when [parallel] monotonous. When processing a wafer at about 200 degrees C - about 700 degrees C (the temperature gradient in an attachment component is also included), and a high-power consistency (for example, 10 W/Cm2) like HDP-CVD is considered and it takes into consideration that it is the extent need more than a maximum of 1000 W/Cm2 and K as alpha, and the maximum adsorption power of an electrostatic chuck is usually 20Torr extent, it turns out that the thickness of the gas reservoir of required helium serves as about 50 micrometers and very small width of face.
[0034] When there is a plasma heat input at the time of heating at a heater, an attaching part changes to a concavo-convex configuration intricately with time amount by the heat input pattern. There are the convex type and concave which show the pattern of the heat deformation at the time of a plasma heat input etc. to drawing 4 at the time of heater heating of an attaching part. Although this heat deformation is influenced of a plasma heat gain, the configuration of an attachment component, the quality of the material, the fixed approach, etc., it reaches the maximum number of about 10 micrometers. It turns out that this can be disregarded as compared with above-mentioned helium gas chamber height of 50 micrometers, and there is nothing.
[0035] This is explained using drawing 5 . For example, helium ** sets to 20Torr(s). Although helium gas chamber height H was 50 micrometers at first, suppose that it deformed into the convex type shown in drawing 4 , and the height of a core became small and was set to 20 micrometers according to heat deformation of an attachment component. alpha at this time is
alpha= about 1100w/Cm2andK (H= 50 micrometers).
alpha= about 1350w/Cm2andK (H= 30 micrometers)
It changes a lot.
[0036] When plasma heat input power density is made into 10 W/Cm2, the temperature rise value in Above alpha is deltaT=91deg (H= 50 micrometers) respectively.
deltaT=74deg (H= 30 micrometers)
A temperature gradient becomes 91-74=17deg in a next door, a core, the periphery section from which the height of helium gas chamber does not change, and a core. That is, if a gas chamber is formed by one, a big difference will be produced in the cooling effect according to the heat deformation which cannot disregard an attachment component, and the temperature distribution on the front face of a wafer will be degraded remarkably.
[0037] The configuration of the temperature rise value in the deformation pattern of each attaching part is respectively shown in drawing 6 . It turns out by whether a heat deformation pattern serves as concave or it becomes a convex that distribution of a temperature rise value will become the opposite if other factors are disregarded.

[0038] The temperature distribution on the front face of a wafer are mainly influenced of the following.
(1) plasma density distribution (2) which is a source of heating distribution (3) of the calorific value of the heater which is a source of heating attachment component front face and wafer flesh-side face-to-face helium gas pressure distribution (4) heat recess (5) by contact in attachment component and the cooling section Coolant gas pressure distribution between attachment component and a cooling room (6) Heat recess between a cooling room and a cooling room stationary plate (7) Thermal radiation to a perimeter chamber internal surface (8) Heat recess to electrostatic chuck covering in an attachment component (9) The amount distribution of cooling on a cooling way etc., If there are very many affectors and it becomes an elevated temperature, it will become very difficult to equalize especially temperature distribution. Moreover, it is desirable to use the controlling factor in the location possible nearest to the wafer rear face used as a controlled system from the point of temperature control responsibility.

[0039] Explanation of the example of this invention is continued below. In drawing 1 , it introduces with mu wave waveguide 27 from reaction chamber 26 wall surface. This mu wave 29 is introduced from mu wave transparency aperture 28, the ECR resonance by the permanent magnet 30 arranged around mu wave transparency aperture 28 is used, a high energy electron is generated, the raw gas supplied from the nozzle 33 of a nozzle ring 32 is dissociated and ionized, and the plasma 34 is generated. A cusp field 35 is formed with the top plate of a reaction chamber 26, and the permanent magnet 30 arranged on the side attachment wall, and the plasma 34 is shut up.
[0040] In order to equalize distribution of **** and helium gas pressure for heat insulators, such as an alumina, for the heat insulation in the contact section of an attaching part and the cooling section, an O ring is fixed through insulating materials 17a and 17b. Thereby, the amount of heat recess can be held down to minimum.
[0041] Or in order to reduce the touch area of an attachment component and a cooling member, it is also possible to consider as a honeycomb structure object as shows a heat insulator to drawing 7 .
[0042] The fiber-optic thermometer probe 16 is connected to Controllers 41A and 41B through the introductory terminal flange 40. This temperature reading value goes into the feedback circuit 42 where the relational data of helium gas pressure and a coefficient of heat-transfer alpha was inputted. Next, from the above-mentioned input data, fluctuated parts delta P1 and delta P2 of helium gas pressure are inputted into helium gas pressure controller 43, and change setting helium gas pressure. helium gas pressure controller 43 consists of mass flow 44 and a pressure gage 45. helium gas is supplied through the regulator and hand valve 46 which are not illustrated from a chemical cylinder 47. The following explains the temperature control approach in detail.
[0043] For example, in a certain process, the case where an attaching part deforms into the configuration of a convex according to heat deformation is considered. The plasma heat input at this time, change (core) of helium gas chamber height H, a wafer temperature change (core), and change of helium pressure are shown in drawing 8 . The heat deformation by the plasma heat input becomes larger as shown in drawing 8 .
[0044] since a heat transfer coefficient alpha becomes small because helium gas chamber height H changes as shown in drawing 9 (alpha1 ->alpha2) -- wafer temperature -- going up -- just -- being alike -- it goes up out of tolerance.
[0045] The comparison operation of the comparison with the measured value from a fiber-optic thermometer and a temperature value to control is carried out by the feedback control shown in step 102 of drawing 10 , when measured value is not a specification value in the comparison of step 104, helium gas pressure is changed to P2 from P1 from the relation shown in drawing 9 at step 106, and helium gas pressure set point to control to a massflow controller is inputted.
[0046] Thereby, wafer temperature changes, as shown in drawing 8 . It becomes possible to carry out temperature control of the wafer core temperature into a certain tolerance by the above-mentioned configuration. The wafer periphery section controls temperature independently

similarly.
[0047] An example of procedure in the case of carrying out membrane formation processing by plasma CVD to a wafer 1 with the semi-conductor processor shown in the above-mentioned example at drawing 11 is shown. Drawing 11 shows time amount change of the heater output Q1, the gas pressure P1 between attachment component - cooling members (core), the gas pressure P2 between attachment component - cooling members (periphery section), the gas pressure P3 between a wafer - an attachment component, the plasma heat input Q2, the skin temperature T1 of an attachment component, and the wafer temperature T2. The axis of abscissa of each graph shows time amount. If it is in the same location by the axis of abscissa, the same time amount is shown.
[0048] (a) Make P1 and P2 into about zero pressure value before [t0] the plasma treatment of the 1st wafer - between t1. By energizing at the heater 8 of an attachment component 2 by t1, generation of heat of Q1 is produced and an attachment component is heated. At this time, P1 and P2 are heat insulation respectively for about zero, and since heat does not escape to a cooling member, a temperature up can be efficiently carried out in the shortest time amount to desired temperature at a heater. A wafer is moved to right above [of an attachment component 2] by a vacuum robot etc. by t2, and a wafer 1 is carried on an attachment component 2 by the wafer rise-and-fall pin which is not illustrated. Next, the seal of approval of the electrical potential difference of plus or minus is carried out to the adsorption electrode 7, and a wafer 1 is adsorbed. By t3, a certain pressure is maintained at the gas chamber between a wafer - an attachment component, and gas is introduced into it. The temperature up of the wafer is carried out to the heated attachment component by contact heat transfer, and it carries out a temperature up by gas heat transfer by t3 t2-t3. Since the heat transfer effectiveness increases remarkably as compared with contact heat transfer in the case of gas heat transfer, a wafer temperature change is large and carries out a temperature up by short time amount. The output of a heater is made small in t4, and it is made 0. Along with this, the skin temperature T1 of an attachment component and the wafer temperature T2 become low, as shown in drawing 11 .
[0049] (b) Carry out plasma ignition at the plasma treatment t5 of the 1st wafer. The heat gain to a wafer 1 shows the case of being large in the core to drawing 11 , as compared with the periphery section. In order to keep constant the temperature of an about [each part of the front face of a wafer], as shown in drawing 8 , gas pressure is changed in each heat transfer gas chamber. In this case, as compared with the core of a wafer, gas pressure of the periphery section is made low, the heat transfer coefficient by gas is reduced, as compared with a core, a temperature rise value is enlarged for the temperature of a wafer 1 in the periphery section, temperature on a wafer side is made high, and the homogeneity of the temperature distribution within the wafer side at the time of a plasma heat input is raised. On the contrary, the periphery section makes relation of gas pressure reverse, when a heat gain is large as compared with a core. Membrane formation gas is introduced into the processing interior of a room after plasma ignition, and the thin film of an oxidation quartz is made to form on the 1st page of a wafer by the chemical reaction. The plasma is extinguished to t6. This is performed by stopping installation of mu wave power, RF power, and membrane formation gas. Thereby, the plasma heat input Q2 decreases, as shown in drawing 11 , it decreases P1, P2, and P3 along with this, and is set to 0. A wafer is lifted by the wafer rise-and-fall pin which does not illustrate a wafer to t7, and a wafer 1 is taken out from a processing room with a vacuum robot.
[0050] (C) Carry in a wafer 1 by the same approach as the above before [t7] the plasma treatment of the 2nd wafer - between t1'. Since the temperature up of heater output Q1' has already been carried out to a certain constant temperature unlike processing of the first wafer, a value smaller than Q1 is enough.
[0051] (d) Since it is the same as that of the first plasma treatment of the 2nd wafer, omit explanation.
[0052] Although the above is controlling each two or more gas chamber formed with a wafer 1 in the gas pressure between a wafer 1 - an attachment component 2 by the same pressure, it makes gas pressure between attachment component - cooling members regularity (gas pressure is set constant in a core and the periphery section.) for every gas chamber, and it is the gas

pressure between a wafer – an attachment component. The same effectiveness is acquired even if it makes it change for every gas chamber. Moreover, the wafer temperature from each part grade is fed back for the calorific value of the heater 8 of not the gas pressure P1, P2, and P3 shown in drawing 11 but a core, and the periphery section, and the same effectiveness can be acquired even if it changes calorific value. Moreover, the same effectiveness as the above is acquired even if it changes the temperature of a cooling medium 10, and a flow rate.
[0053] At the temperature of a cooling medium 10, the direct control of the temperature distribution of the cooling member 3 can be carried out, and the cooling effect can be changed by the cooling flow rate, the film temperature in cooling passage is changed, by that of ****, similarly the temperature distribution in a cooling member are changed, and things become possible.
[0054] After all, even when gas pressure P1, P2, and P3 is fixed, it becomes possible to control wafer temperature distribution in a certain constant value as well as the above. However, a control rate has [the case where the gas pressure of a wafer 1 and an attachment component 2 is changed for every each part grade] the controllability best when it thinks from the responsibility of control early.
[0055] Although Q1, P1, P2, P3, and Q2 grade which are shown in drawing 11 are set and serve as constant value after a certain fixed time amount in drawing 11 , you may make it change for every time amount. Especially P1 and P2 are good for a plasma heat input to make it change in the common heat input pattern which changes every moment.
[0056] Moreover, in drawing 11 , although it has become since a heater output is set to 0, a heater may perform pressure-up initiation of gas pressure P1 and P2 from the time of ON. Gas pressure P3 may be performed after a heater output serves as OFF.
[0057] Although drawing 11 does not show an example and does not indicate it one by one here, it has various deformation.
[0058] Another example of this invention is shown in drawing 12 . The difference with drawing 1 divides helium gas pressure between an attachment component 2 and a wafer 1 into a core, the periphery section, or the independent part beyond it (two or more heat transfer gas chambers), and form in the interior of an attachment component 2 the path of the heat transfer gas which is not illustrated, each heat transfer gas chamber is made open for free passage, and it changes helium gas pressure in the core and the periphery section on the rear face of a wafer. Separation of the part of a gas chamber is formed by the concave of an electrostatic chuck front face, and the convex (slot).
[0059] This structural drawing is shown in drawing 13 . As shown in drawing 13 , form the soil hand part 200 in the pars intermedia of an attachment component 2, arrange adsorption electrode 7b under the soil hand part 200, it is made to become independent of other adsorption electrode 7a, bigger bias voltage than other adsorption electrodes is impressed, a wafer is adsorbed, and at least each part is reducing the amount of helium gas leaks of a between. Although the soil hand part 200 separated ** of an electrostatic chuck front face only into two places in drawing 13 , there may be how many of these. Moreover, the slit of small width of face may be prepared in a soil hand part. However, let slit width be what has small extent which can control a pressure independently at every [which carries processing objects, such as a wafer, and is formed] each part grade (heat transfer gas chamber).
[0060] Here, the above, a wafer 1, and the pattern that prepares two or more heat transfer gas chambers in the space of the front face of an attachment component 2 are set to A, and the pattern which prepares two or more heat transfer gas chambers in the space of an attachment component 2 and the cooling member 3 is set to B.
[0061] What is necessary is just to adopt the above or Patterns A and B at least, in order to raise temperature homogeneity and to process a wafer 1. Since the detection temperature used as a controlled system increases when both patterns A and B are adopted, it is desirable for problems, like control is difficult to occur and to adopt only patterns A or B.
[0062] Another example of this invention is shown in drawing 14 . The difference with drawing 1 changes the calorific value of a heater to the temperature control of a wafer for every part. For example, at drawing 14 , it forms by core heater 8b and heater 8a of the periphery section.

Heaters 8a and 8b are turned off with a changeover switch 57 at the time of RF impression. The difference in in the indicated value of the temperature measurement controller 41 and desired value which measure the temperature of a wafer rear face is detected in a feedback circuit 42, and the set point of the power conditioners 56A and 56B of a heater is changed.
[0063] Another example of this invention is shown in drawing 15 . The difference with drawing 1 changes the temperature of cooling water, and a flow rate to the temperature control of a wafer for every part. In drawing 15 , it forms in the cooling water way of a core and the periphery section. The difference between the indicated value of the temperature measurement controller 41 and desired value is detected in a feedback circuit 42, and the temperature set point of the cooling water of the chiller 58 which has cooling and a heating function, and a flow rate are changed. A flow rate is changed, the heat transfer coefficient alpha in the wall surface of cooling passage is changed, and the temperature gradient in a wall surface is controlled. However, since the heat capacity of the cooling medium in a chiller is large, compared with what used the heater, responsibility is bad.
[0064]
[Effect of the Invention] According to this invention, it becomes possible to maintain the homogeneity of temperature distribution and to carry out plasma treatment of the sample at an elevated temperature, and a quality processed sample can be offered.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional side elevation of the semi-conductor processor in which the 1st example of this invention is shown.
[Drawing 2] It is each top view of an attachment component and a cooling member in the example of drawing 1 .
[Drawing 3] It is drawing showing the relation between helium gas pressure and a heat transfer coefficient.
[Drawing 4] It is drawing showing deformation of the attachment component at the time of a plasma heat input.
[Drawing 5] It is drawing showing the relation between helium gas pressure when the thickness of helium gas reservoir changes, and a heat transfer coefficient.
[Drawing 6] It is drawing showing the wafer temperature rise distribution by heat deformation of an attachment component.
[Drawing 7] It is drawing showing the structure of the insulating material inserted between an attachment component and a cooling member.
[Drawing 8] It is drawing showing deformation of the attachment component at the time of plasma treatment, and a temperature change.
[Drawing 9] It is drawing showing the relation between helium gas pressure when the thickness of helium gas reservoir changes, and a heat transfer coefficient.
[Drawing 10] It is drawing showing a temperature control flow.
[Drawing 11] It is the chart Fig. showing the example of a processing flow of the semi-conductor processor shown in the 1st example of this invention.
[Drawing 12] It is the sectional side elevation of the semi-conductor processor in which the 2nd example of this invention is shown.
[Drawing 13] It is drawing showing the side cross section of the electrostatic chuck section.
[Drawing 14] It is the sectional side elevation of the semi-conductor processor in which the 3rd example of this invention is shown.
[Drawing 15] It is the sectional side elevation of the semi-conductor processor in which the 4th example of this invention is shown.
[Drawing 16] It is drawing showing the relation between wafer temperature and membraneous quality.
[Description of Notations]
1 -- Wafer 2 [-- High-temperature-service adsorber,] -- An attachment component, 3 -- A cooling member, 4 5 -- An electrostatic chuck member, 6 -- An electrostatic chuck member support plate, 7a, 7b -- Adsorption electrode, 8a [-- Cooling passage,] -- A periphery heater, 8b -- A core heater, 10 -- A cooling medium, 11 12 [-- O ring,] -- helium gas passageway, 13 -- helium gas chamber, 14 -- An O ring, 10-15 16 -- A fiber-optic thermometer probe, 17a, b-- insulating material, 18 -- Insulating material, 20 [-- mu wave waveguide,] -- A high-temperature-service electrostatic adsorber support plate, 21 -- An insulating material, 26 -- A reaction chamber, 27 28 [-- Nozzle,] -- mu wave transparency aperture, 29 -- mu wave, a permanent magnet, 32 -- A nozzle ring, 33 34 [-- Flange,] -- The plasma, 35 -- A cusp field,

36 -- Line of magnetic force, 37 38 -- An exhaust air hole, 40 -- A terminal installation flange, 41 -- Temperature measurement controller, 42 -- A feedback circuit, 43 -- A pressure controller, 44 -- Mass flow, 45 [-- A main valve, 51 / -- A turbo molecular pump, 52 / -- A dry pump, 55 / -- Plasma heat input / 56 / -- Chiller / -- A power conditioner, 57 -- A switch, 58] -- A manometer, 46 -- A hand valve, 47 -- The gas for cooling, 50

[Translation done.]

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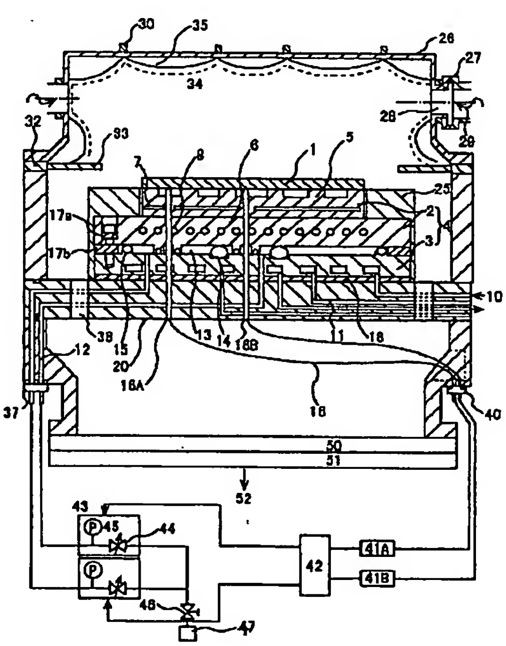
(54)【発明の名称】　試料の処理装置及び試料の処理方法

(57)【要約】

【課題】従来技術では、ﾋｰﾀ加熱時またはﾌﾟﾗｽﾞﾏ入熱時、時間とともに変化する入熱分を応答性良く、抜熱しｳｴﾊｰ温度を一定に保つ事は出来ない。高温でｳｴﾊｰ等を処理する場合に、ｳｴﾊｰ面内での温度分布は著しく劣化する。また、ｳｴﾊｰの昇温温度を十分高くできないので、良質なﾌﾟﾗｽﾞﾏ処理が不可である。

【解決手段】吸着装置に保持された試料の温度を制御しつつ、該試料をﾌﾟﾗｽﾞﾏ処理する試料の処理装置において、前記吸着装置は、試料を保持する為の保持部材と冷却を行う冷却部材とを有し、前記冷却部材に該冷却部材と前記保持部材との間に第1の伝熱ｶﾞｽ室部を形成するための凹部を設け、前記試料が保持された状態における前記保持部材と前記試料との間に第2の伝熱ｶﾞｽ室部を形成するための凹部を前記保持部材に設け、前記第1、第2の伝熱ｶﾞｽ室部のいずれか一方を、独立して圧力制御可能な複数個の伝熱ｶﾞｽ室で構成した。

図 1



【特許請求の範囲】
【請求項１】吸着装置に保持された試料の温度を制御しつつ、該試料をﾌﾟﾗｽﾞﾏ処理する試料の処理装置において、
前記吸着装置は、前記試料の中心部と外周部に対応して区分された複数の伝熱ｶﾞｽ室を備えており、
前記試料の温度に応じて各伝熱ｶﾞｽ室の圧力を独立に制御する手段を備えたことを特徴とする試料の処理装置。
【請求項２】吸着装置に保持された試料の温度を制御しつつ、該試料をﾌﾟﾗｽﾞﾏ処理する試料の処理装置において、
ﾌﾟﾗｽﾞﾏ処理時に、前記試料の中心部および外周部の温度を５００±５０℃から７００±５０℃に維持して処理する手段を備えたことを特徴とする試料の処理装置。
【請求項３】吸着装置に保持された試料の温度を制御しつつ、該試料をﾌﾟﾗｽﾞﾏ処理する試料の処理装置において、
前記吸着装置は、試料を保持する為の保持部材と該保持部材を介して試料の冷却を行う冷却部材とを有し、前記保持部材と前記冷却部材との間に独立して圧力制御可能な伝熱ｶﾞｽ室を複数個形成したことを特徴とする試料の処理装置。
【請求項４】吸着装置に保持された試料の温度を制御しつつ、該試料をﾌﾟﾗｽﾞﾏ処理する試料の処理装置において、
前記吸着装置は、試料を保持する為の保持部材と冷却を行う冷却部材とを有し、前記試料が保持された状態で前記保持部材と前記試料との間に独立して圧力制御可能な伝熱ｶﾞｽ室を複数個形成するための凹部を前記保持部材に設けたことを特徴とする試料の処理装置。
【請求項５】吸着装置に保持された試料の温度を制御しつつ、該試料をﾌﾟﾗｽﾞﾏ処理する試料の処理装置において、
前記吸着装置は、試料を保持する為の保持部材と冷却を行う冷却部材とを有し、前記冷却部材に該冷却部材と前記保持部材との間に第１の伝熱ｶﾞｽ室部を形成するための凹部を設け、
前記試料が保持された状態における前記保持部材と前記試料との間に第２の伝熱ｶﾞｽ室部を形成するための凹部を前記保持部材に設け、
前記第１、第２の伝熱ｶﾞｽ室部のいずれか一方を、独立して圧力制御可能な複数個の伝熱ｶﾞｽ室で構成したことを特徴とする試料の処理装置。
【請求項６】請求項３ないし５のいずれかにおいて、前記複数個の伝熱ｶﾞｽ室は、前記試料の中心部と外周部に対応して設けられた少なくとも２つの室を有しており、前記保持部の熱変形ﾊﾟﾀｰﾝに応じて、該熱変形を押さえるように前記半径方向内側と外側の各室の圧力制御を行うことを特徴とする試料の処理装置。
【請求項７】請求項１、３ないし６のいずれかにおいて、前記複数個の伝熱ｶﾞｽ室に対応した複数の位置で前記試料裏面の温度を計測する為の温度計を有し、該温度値をﾌｨｰﾄﾞﾊﾞｯｸして前記試料温度の制御因子を制御することを特徴とする試料の処理装置。
【請求項８】請求項１ないし６のいずれかにおいて、前記試料の処理装置が試料を高温で処理するものであり、前記保持部材内にﾋｰﾀを有し、前記冷却部材に冷却媒体の流路を有し、
前記複数のｶﾞｽ室相互間の分離に耐熱性の弾性体を使用したことを特徴とする試料の処理装置。
【請求項９】請求項８において、前記制御因子として、試料と前記保持部材間の伝熱ｶﾞｽの圧力、前記保持部材と前記冷却部材間の伝熱ｶﾞｽ圧力、ﾋｰﾀ加熱量、冷却媒体の温度、流量を各部位毎に制御する事を特徴とする試料の処理装置。
【請求項１０】請求項８において、前記保持部材と前記冷却部材とを間に絶縁物を介し固定することを特徴とする試料の処理装置。
【請求項１１】請求項７において、処理時の温度を前記試料の中心部および外周部で５００±５０℃から７００±５０℃に維持して処理することを特徴とする試料の処理装置。
【請求項１２】吸着装置に保持された試料の温度を制御しつつ、該試料をﾌﾟﾗｽﾞﾏ処理する試料の処理方法において、
前記吸着装置は、前記試料の中心部と外周部に対応して区分された複数の伝熱ｶﾞｽ室を備えており、
前記試料の温度に応じて前記複数の伝熱ｶﾞｽ室の圧力を独立に制御して、前記試料をﾌﾟﾗｽﾞﾏ処理することを特徴とする試料の処理方法。
【請求項１３】吸着装置に保持された試料の温度を制御しつつ、該試料をﾌﾟﾗｽﾞﾏ処理する試料の処理方法において、
ﾌﾟﾗｽﾞﾏ処理時に、前記試料の中心部および外周部の温度を５００±５０℃から７００±５０℃に維持して処理することを特徴とする試料の処理方法。
【請求項１４】保持部材と冷却部材を有する吸着装置に保持された試料の温度を制御しつつ、該試料をﾌﾟﾗｽﾞﾏ処理する試料の処理方法において、
前記冷却部材と前記保持部材との間に第１の伝熱ｶﾞｽ室部を有し、前記保持部材と前記試料との間に第２の伝熱ｶﾞｽ室部を有し、前記第１の伝熱ｶﾞｽ室部及び前記第２の伝熱ｶﾞｽ室部の少なくとも１つは、試料の中心部と外周部に区分された複数の伝熱ｶﾞｽ室で構成されており、
前記複数の伝熱ｶﾞｽ室の圧力を独立に制御して、処理時の温度を前記試料の中心部および外周部で５００±５０℃から７００±５０℃に維持して処理することを特徴とする試料の処理装置。
【請求項１５】処理室に試料を真空ﾛﾎﾞｯﾄ等の搬送系により搬入する工程と、前記試料を前記処理室内のﾋｰﾀと

吸着電極とを含んだ保持部材に搭載する工程と、前記試料を前記保持部材に吸着する工程と、前記保持部材内のヒータにより加熱する工程と、前記試料と前記保持部材間に圧力をコントロールしてガスを供給する工程と、冷却流路を有する冷却部材と前記保持部材間に圧力をコントロールしてガスを供給する工程と、前記冷却部材に温度、流量をコントロールして冷却媒体を供給する工程と、前記処理室内にプラズマを発生させる工程と、前記試料を前記保持部材から脱着する工程と、前記試料を前記処理室より搬出する工程を含むことを特徴とする試料の処理方法。

【請求項１６】保持部材と冷却部材を有する吸着装置に保持された試料の温度を制御しつつ、該試料をプラズマ処理する試料の処理方法において、

前記冷却部材と前記保持部材との間に第１の伝熱ガス室部を有し、前記保持部材と前記試料との間に第２の伝熱ガス室部を有し、前記第１の伝熱ガス室部及び前記第２の伝熱ガス室部の少なくとも１つは複数の伝熱ガス室で構成されており、

前記試料の裏面の温度を中心部、外周部等の２ヶ所以上において実測する工程と、該温度の実測値と設定値との差異を検出する工程と、前記第１の伝熱ガス室、前記第２の伝熱ガス室のガス室毎のガス圧力、ヒータの加熱量、冷却媒体の流量、温度の少なくとも１つを制御する工程とを含むことを特徴とする試料の処理方法。

【請求項１７】保持部材と冷却部材を有する吸着装置に保持された試料の温度を制御しつつ、該試料をプラズマ処理する試料の処理方法において、

前記冷却部材と前記保持部材との間に第１の伝熱ガス室部を有し、前記保持部材と前記試料との間に第２の伝熱ガス室部を有し、前記第１の伝熱ガス室部及び前記第２の伝熱ガス室部の少なくとも１つは複数の伝熱ガス室で構成されており、

前記複数個の伝熱ガス室は、前記試料の中心部と外周部に対応して設けられた少なくとも２つの室を有しており、前記保持部の熱変形パターンに応じて、該熱変形を押さえるように前記中心部と外周部の各室の圧力制御を行うことを特徴とする試料の処理方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明はウエハー等の試料の処理装置及び試料の処理方法に係り、特に、ＣＶＤ装置などの半導体製造装置に用いられる高温型吸着装置とこの高温型吸着装置による試料の処理方法およびこれを搭載するＣＶＤ装置などの半導体製造装置に関する。本発明は、もちろん、液晶プラズマ処理装置、スパッタ装置等にも適用可能である。

【０００２】

【従来の技術】半導体処理装置に関し、近年の微細化、高アスペクト比の層間絶縁膜埋め込みにおいては、従来の方法（TEOS-O3　ＣＶＤ等）と比較して処理後の膜劣化、プロセス数の少ない、ＨＤＰ－ＣＶＤ（高密度プラズマＣＶＤ）が注目されているが、このＨＤＰ－ＣＶＤではこの層間絶縁膜の膜質としては、熱酸化膜と同等レベルをユーザから要求されている。

【０００３】図１６に、基板温度と膜質（熱酸化膜のエッチング速度比）との関係を示す。この図より、熱酸化膜と同様な膜質を得る為には、基板温度は６００℃近傍の高温まで上昇させなければならない事が判る。又、ウエハー面内で温度分布は膜質分布より必要とされる温度分布範囲内とする必要がある。

【０００４】上記要求に対して、従来実際行われている方法は、静電チャックとウエハー間のＨｅ圧力を高真空近傍とし、熱絶縁して昇温するものである。しかし、この方法では、周囲への熱輻射による熱逃げ、他の部材との接触部で熱伝導による熱逃げ等が有り、十分に温度を上げる事は出来ないし、高温の昇温時に温度分布が、著しく劣化するという問題点がある。

【０００５】ここで、ウエハー表面温度を制御するための従来技術の概略構造と問題点を述べる。

【０００６】まず、特開平９－１７８４９号公報には、窒化物セラミックス基材にヒータを埋め込んだ半導体ウエハー保持部材と金属製の冷却装置との間に耐熱材料製の繊維の結合体または発泡材の介在層を有する構造が記載されている。

【０００７】また、特開平１０-６４９８５号公報には、高温型吸着装置にウエハーステージにヒータと冷却配管を有するものが開示されている。すなわち、保持部材にヒータを持ち、これにて保持部材を昇温させると、同時にプラズマからの入熱分を抜熱する冷却部とを一体化する構造が記載されている。

【０００８】上記特開平９－１７８４９号公報に記載のものは、下記の問題点があり、プラズマ入熱時に一定温度範囲内に温度制御する事は出来ないと考えられる。

（１）　時間で変化するプラズマから入熱分の抜熱に上記介在層に圧力を加え、保持部材と冷却装置との間の熱伝達量を調整する構造であるが、実際、時々刻々変化するプラズマ入熱量に対応し、介在物の圧力を変化させる事はかなり難しい。

（２）　ＨＤＰ－ＣＶＤのようなウエハー面上でのパワー密度が１０W/Cm2におよぶような高パワー密度となると、上記のような介在層に圧力を加え抜熱するような構造では抜熱を十分行う事は実際かなり難しい。

【０００９】次に、特開平１０-６４９８５号公報に記載のものも、同様に下記問題点により、プラズマ入熱時、ウエハー表面温度を一定温度範囲内に制御する事は出来ないと考えられる。

【００１０】(1)　ウエハー処理温度を数百℃とする場合、冷却配管の壁面は金属製ジャケットで大きな温度勾配を持たせる場合であっても、例えば２００℃程度を超えてしまう。このような高温でも、気化せず安価で安全に

半導体製造装置に使用できる冷却媒体種はかなり数が制限される。
(2)　上記冷却媒体でウエハーへの入熱パワー密度がＨＤＰ－ＣＶＤのように１０W/Cm2程度の大きなパワー密度に達する場合、十分に抜熱するには壁面での熱伝達係数を十分大きくとれない為、伝熱面積を十分大きくする必要が有るが、現実的には冷却ジャケットの面積の制限から十分冷却効果が取れない問題がある。
(3)　静電チャックを高温加熱する場合、静電チャック自身の熱変形を許容値以内に抑える為には、金属製ジャケットに十分剛性をもたせる必要が有り、厚みを十分大きく製作する必要がある。この為、静電チャック自体が重くなりメンテ性が悪くなる等問題点がある。
(4)　入熱量が時々刻々に変化するプラズマ処理中において、入熱増加、減少分に応じ て加熱または冷却する場合、静電吸着装置の熱容量が大きい為、応答性良く、温度をある一定範囲内にする為には、かなり大きな加熱能力を有するヒータまたは冷却能力を有する冷却ユニットが必要で現実的ではない。
【００１１】一方、特開平２-１３５７５３号公報の第７図には、試料と電極との間にガスを導入するための空間が形成されるとともに、電極と試料台との間にもガスを導入するための空間が設けられたものが記載されている。
【００１２】この公報に記載のものも、上記と同様の問題点があり、プラズマ入熱時に一定温度範囲内に温度制御する事は出来ないと考えられる。
【００１３】
【発明が解決しようとする課題】従来技術の問題点は上記した通りであるが、要点を下記する。
(1)　ヒータ加熱時、及びプラズマ入熱時、時々刻々変化する入熱量に対応して、保持部材と冷却装置間での十分に応答性良く熱伝達量を変化させる事が出来ず、ウエハーの表面温度分布の均一性が劣化する。
(2)　ウエハー保持部材の加熱温度が例えば３００℃程度を超える場合には、保持部材と冷却部材とに、十分大きな温度勾配をつけれないので、冷却部材の壁面が２００℃を超える。このような条件で安全、安価で十分な冷却性能を得られる冷却媒体種はかなり少ない。
(3)　ウエハー処理温度が３００℃程度を超える場合で、ＨＤＰ-ＣＶＤのようなパワー密度が１０W/Cm2程度となる大きな入熱がある場合、使用できる冷却媒体で十分な冷却能力を持てず、ウエハーの表面温度分布の均一性が劣化する。
(4)　静電チャックの熱変形を許容値内に抑える為、冷却部を十分剛性を大きくする必要があるが、これにより冷却板が重くなり、メンテ性が著しく劣化する問題が有る。
(5)　静電吸着装置の熱容量が大きい為、時々刻々変化するプラズマ入熱に対応して応答性良く、ある温度範囲に静電吸着装置の温度を制御するにはかなり大きなヒータまたは冷却能力を有する冷却ユニットが必要であり、装置の大型化、コストアップとなる。
【００１４】本発明は、上記各事項を考慮し、膜質の均一性劣化を生ずる試料表面の温度不均一性を解消し、膜質の良好な均一性の高い処理済試料を提供することを目的とする。
【００１５】
【課題を解決するための手段】本発明は、上記課題を解決する為、吸着装置に保持された試料の温度を制御しつつ、該試料をプラズマ処理する試料の処理装置において、前記吸着装置は、前記試料の中心部と外周部に対応して区分された複数の伝熱ガス室を備えており、前記試料の温度に応じて各伝熱ガス室の圧力を独立に制御する手段を備えたことを特徴とする。
【００１６】本発明の他の特徴は、吸着装置に保持された試料の温度を制御しつつ、該試料をプラズマ処理する試料の処理装置において、プラズマ処理時に、前記試料の中心部および外周部の温度を５００±５０℃から７００±５０℃に維持して処理する手段を備えたことにある。
【００１７】本発明の他の特徴は、吸着装置に保持された試料の温度を制御しつつ、該試料をプラズマ処理する試料の処理装置において、前記吸着装置は、試料を保持する為の保持部材と該保持部材を介して試料の冷却を行う冷却部材とを有し、前記保持部材と前記冷却部材との間に独立して圧力制御可能な伝熱ガス室を複数個形成したことにある。
【００１８】本発明の他の特徴は、吸着装置に保持された試料の温度を制御しつつ、該試料をプラズマ処理する試料の処理装置において、前記吸着装置は、試料を保持する為の保持部材と冷却を行う冷却部材とを有し、前記試料が保持された状態で前記保持部材と前記試料との間に独立して圧力制御可能な伝熱ガス室を複数個形成するための凹部を前記保持部材に設けたことにある。
【００１９】本発明の他の特徴は、吸着装置に保持された試料の温度を制御しつつ、該試料をプラズマ処理する試料の処理装置において、前記吸着装置は、試料を保持する為の保持部材と冷却を行う冷却部材とを有し、前記冷却部材に該冷却部材と前記保持部材との間に第１の伝熱ガス室部を形成するための凹部を設け、前記試料が保持された状態における前記保持部材と前記試料との間に第２の伝熱ガス室部を形成するための凹部を前記保持部材に設け、前記第１、第２の伝熱ガス室部のいずれか一方を、独立して圧力制御可能な複数個の伝熱ガス室で構成したことにある。
【００２０】本発明の他の特徴は、前記複数個の伝熱ガス室は、前記試料の中心部と外周部に対応して設けられた少なくとも２つの室を有しており、前記保持部の熱変形パターンに応じて、該熱変形を押さえるように前記半径方向内側と外側の各室の圧力制御を行うことにある。
【００２１】本発明の他の特徴は、吸着装置に保持され

た試料の温度を制御しつつ、該試料をﾌﾟﾗｽﾞﾏ処理する試料の処理方法において、前記吸着装置は、前記試料の中心部と外周部に対応して区分された複数の伝熱ｶﾞｽ室を備えており、前記試料の温度に応じて前記複数の伝熱ｶﾞｽ室の圧力を独立に制御して、前記試料をﾌﾟﾗｽﾞﾏ処理することにある。

【００２２】本発明によれば、試料を高温で温度分布の均一性を保ち、ﾌﾟﾗｽﾞﾏ処理する事が可能となり、高品質な処理済試料を提供できる。

【００２３】本発明のより具体的な特徴を列挙すると次の通りである。

(1)　保持部材とｳｴﾊｰ裏面間、保持部材と冷却部材間に伝熱ｶﾞｽ室を設けた。またｶﾞｽ室を２個所以上の部位に分離した。例えば、ｳｴﾊｰ中心部、外周部というように２個所に分離した。

(2)　上記ｶﾞｽ室分離の為、保持部材と冷却部材との間に耐熱性を有する弾性体（例えば、ﾊﾞｲﾄﾝOﾘﾝｸﾞ等）を使用した。また、ﾋｰﾀを内蔵した静電ﾁｬｯｸを含む保持部材の加熱時の熱変形量を考慮し、ｼｰﾙを保持できるｼｰﾙ材の太さを考慮し、熱変形後もＨｅｶﾞｽ圧を保てるようにOﾘﾝｸﾞの溝深さ、及び、Oﾘﾝｸﾞ保持構造とした。

(3)　各部位毎にｳｴﾊｰ裏面の温度を測定する為の温度計を配置し、ｳｴﾊｰ温度測定値と目標値との差異を検知し、制御因子を制御するｺﾝﾄﾛｰﾗを用い、独立に制御した。

(4)　上記制御因子として、ｳｴﾊｰ裏面と保持部材表面間、および保持部材と冷却部材間のＨｅｶﾞｽ圧力、ﾋｰﾀ加熱量、冷却媒体の温度、流量を変化させた。

(5)　熱逃げを抑制する為、保持部材と冷却部材との接触面に熱絶縁物を配置した。

(6)　上記、熱絶縁物の接触面積を小さくする為、軽量で強度のあるﾊﾆｶﾑ構造等を用いた。

【００２４】(1)　本発明によれば、上記特徴（１）を採用する事によって、保持部材と冷却部材との間の熱伝達係数を伝熱ｶﾞｽの圧力によって自由に応答性良く変化させれるので、完全断熱状態から強制水冷の約数分の１程度の熱伝達効果を得る事が可能になる。

(2)　上記特徴（１）を採用する事によって、ｳｴﾊｰ面上の温度均一性を劣化させている各部位毎に伝熱ｶﾞｽ室を分離できるので、独立して各部位毎に温度制御が可能となり、ｳｴﾊｰの温度均一性を向上させる事が可能となる。

(3)　上記特徴（２）を採用する事によって、伝熱ｶﾞｽ室の分離に耐熱性の弾性体を使用する事で、ｳｴﾊｰ保持部の熱変形による伝熱ｶﾞｽ室間でのｶﾞｽﾘｰｸを防止でき、伝熱ｶﾞｽ室を分離できるので、独立して各部位毎に温度制御が可能となり、ｳｴﾊｰの温度均一性を向上させる事が可能となる。

(4)　上記特徴（３）を採用する事によって、各部位毎の測温し、目標値になるようﾌｨｰﾄﾞﾊﾞｯｸできるので各部位毎にｳｴﾊｰ表面温度分布を均一化できる。

(5)　上記特徴（４）を採用する事によって、ｳｴﾊｰ裏面と保持部材表面間、および保持部材と冷却部材間のＨｅｶﾞｽ圧力、ﾋｰﾀ加熱量、冷却媒体の温度、流量の少なくとも１つの制御因子を制御する事で、ｳｴﾊｰの温度均一性を向上させる事が可能となる。

(6)　上記特徴（５）を採用する事によって、保持部材と冷却部材間の接触面で生じる熱逃げを防止しｳｴﾊｰの温度均一性を向上させる事が可能となる。

(7)　上記特徴（６）を採用する事によって、保持部材と冷却部材間の接触面での熱逃げを防止しｳｴﾊｰの温度均一性を向上させる事が可能となる。

【００２５】なお、本発明は、半導体等のｳｴﾊｰのみでなく液晶製造装置、ﾌﾟﾗｽﾞﾏｴｯﾁﾝｸﾞ装置、ｽﾊﾟｯﾀ 装 置等にも適用可能である。

【００２６】

【発明の実施の形態】以下、本発明の実施例を説明する。図１は本発明の第１の実施例を示すﾌﾟﾗｽﾞﾏ処理装置の概略図であり、図２は、図１の実施例における保持部材と冷却部材の各平面図である。以下、ﾌﾟﾗｽﾞﾏＣＶＤ装置を例にして説明する。ﾌﾟﾗｽﾞﾏＣＶＤ装置は、反応室２６と、この反応室２６内にμ波２９を導入するμ波導波管２７と、μ波透過窓２８の回りに配置した永久磁石３０と、反応室２６内に処理ｶﾞｽを供給するﾉｽﾞﾙ３３を備えている。また、保持部材２と冷却部材３で形成される高温型静電ﾁｬｯｸ４を備えている。試料即ちｳｴﾊｰ１等の処理対象物は、処理時、高温型静電ﾁｬｯｸ４によって静電吸着される。

【００２７】静電ﾁｬｯｸ部材５は、ｳｴﾊｰ面側の表面を凹凸に高さ数十μmから数百μmの凹凸の加工されている。図２に示すように、静電ﾁｬｯｸ部材５の外周縁には環状の土手部２Ｄが形成され外周辺からのＨｅｶﾞｽﾘｰｸ量を制限している。また、内側の２つの土手部により静電ﾁｬｯｸ表面は３個所（２Ａ～２Ｃ）に分離され、各土手部に小さな幅のｽﾘｯﾄが設けられている。

【００２８】保持部材２の内部には正、負用の２ケの吸着電極７を含んでいる。吸着電極７は図示しない直流ﾊﾞｲｱｽ電源で正負の電圧を印加されている。静電ﾁｬｯｸ部支持板６はﾋｰﾀ８を内蔵しており、静電ﾁｬｯｸ部材５を一定時間内に一定温度まで昇温する。静電ﾁｬｯｸ部材５と静電ﾁｬｯｸ部支持板６とはIn等のろう付け又は金属接合等で接合されている。静電ﾁｬｯｸ部材５と静電ﾁｬｯｸ部支持板６は加熱時の熱変形を抑制する為、熱膨張係数をある範囲内で合わせるとか、間に傾斜材料を挟む等の手法がとられる場合がある。

【００２９】冷却部材３の内部には、冷却媒体１０用の冷却流路１１とＨｅｶﾞｽ用流路１２が有る。

【００３０】冷却部材３の上面すなわち、保持部材２側の面には、図２に示すように２つの伝熱ｶﾞｽ室用空間１３Ａ、１３Ｂが設けられており、各伝熱ｶﾞｽ室用空間１３Ａ、１３Ｂの仕切りには耐熱性が高い弾性体（例えば、ﾊﾞｲﾄﾝOﾘﾝｸﾞ）１４が使用される。又、冷却部材３

の外周部にOﾘﾝｸﾞ１５を配置し、保持部材２と冷却部材３との隙間を伝わり、ﾘｰｸするＨｅ量を無くし、ｳｴﾊｰ温度の均一性を向上させる。図１、図２の例では冷却部材３の上面が半径方向の内外２個所に区切られているのみであるが、数個所に伝熱ｶﾞｽ室用空間を分離、形成する事も可能である。これらの伝熱ｶﾞｽ室用空間と保持部材２の下面とにより、ｶﾞｽ室１３が形成される。温度分布の均一性をより向上させる為には、伝熱ｶﾞｽ室１３を複数個に分離形成した方が有利である。また、試料の径が大きいものでは、半径方向を３個所に区切る、あるいは半径方向に加えて、円周方向にも複数に区切って、圧力制御可能な複数の伝熱ｶﾞｽ室を設けても良い。

【００３１】保持部材２と冷却部材３との熱絶縁の為、絶縁物１７a，bを挟んでネジ等で、固定する。高温型静電ﾁｬｯｸ４と高温型静電ﾁｬｯｸ用支持板２０との絶縁の為、絶縁物１８を挟んでいる。これは、高温型静電ﾁｬｯｸ４に高周波が印加される場合、又静電ﾁｬｯｸ部材に図示してないＲＦ電極に高周波が印加される場合の高周波絶縁に使用されるもので、テフロン（登録商標）、ｱﾙﾐﾅ等の材料が使用される。

【００３２】１６は光ﾌｧｲﾊﾞｰ温度計ﾌﾟﾛｰﾌﾞであり、ｳｴﾊｰｳｴﾊｰ裏面の温度を測定するものである。このﾌﾟﾛｰﾌﾞ部分の穴を利用してｳｴﾊｰｳｴﾊｰ裏面の空間２Ａ～２Ｃの空間に供給される伝熱ｶﾞｽの通路を形成しても良い。また、ｳｴﾊｰ昇降ﾋﾟﾝの通路を形成しても良い。高温型静電ﾁｬｯｸ４の金属面には、ｽﾊﾟｯﾀによる金属汚染を発生しないようにｶﾊﾞｰ２５が配置される。

【００３３】本発明で上記伝熱ｶﾞｽ室１３を２ケ以上の部位に分離した理由を下記する。ｶﾞｽ室内のＨｅｶﾞｽ圧と熱伝達係 数αの関係は平行平板の場合、図３に示すようになる。ｳｴﾊｰを約２００℃～約７００℃（保持部材での温度勾配も含む）で処理する場合、ＨＤＰ－ＣＶＤのような高ﾊﾟﾜｰ密度（例えば１０W/Cm^2）を考えた場合、αとして最大１０００W/Cm^2・Ｋ以上程度必要であり、静電ﾁｬｯｸの最大吸着力が通常２０Torr程度である事を考慮すると、必要なＨｅのｶﾞｽ層の厚みは約５０μm程度と大変小さい幅となる事が判る。

【００３４】ﾋｰﾀによる加熱時、ﾌﾟﾗｽﾞﾏ入熱がある場合は、入熱ﾊﾟﾀｰﾝで保持部は時間とともに凹凸の形状に複雑に変化する。保持部のﾋｰﾀ加熱時、ﾌﾟﾗｽﾞﾏ入熱時等の熱変形のﾊﾟﾀｰﾝを図４に示す、凸型、凹型がある。この熱変形量はﾌﾟﾗｽﾞﾏ入熱量、保持部材の形状、材質、固定方法等の影響を受けるが、最大数十μm程度に達する。これは上記Ｈｅｶﾞｽ室高さ５０μmと比較して無視できるもので無いことがわかる。

【００３５】これを図５を用いて説明する。例えば、Ｈｅ圧が２０Torrとする。最初、Ｈｅガス室高さＨが５０μmであったが、保持部材の熱変形により、図４に示す凸型に変形し中心部の高さが小さくなり、２０μmとなったとする。この時のαは、

α=約１１００W/Cm^2・Ｋ（H=５０μm）

α=約１３５０W/Cm^2・Ｋ（H=３０μm）

と大きく変化する。

【００３６】ﾌﾟﾗｽﾞﾏ入熱ﾊﾟﾜｰ密度を１０W/Cm^{2}とすると、上記αでの温度上昇値は各々、

ΔT＝９１deg（H=５０μm）

ΔT＝７４deg（H=３０μm）

となり、中心部とＨｅｶﾞｽ室の高さが変化しない外周部と中心部で温度差は９１-７４=１７degになる。つまり、ｶﾞｽ室を一つで形成すると、保持部材の無視できない熱変形により冷却効果に大きな差異を生じ、ｳｴﾊｰ表面の温度分布を著しく劣化させる。

【００３７】各保持部の変形ﾊﾟﾀｰﾝでの温度上昇値の形状を各々図６に示す。熱変形ﾊﾟﾀｰﾝが凹となるか凸になるかで、温度上昇値の分布は他の要因を無視すると正反対になる事が判る。

【００３８】ｳｴﾊｰ表面の温度分布は主に下記の影響を受けている。

（１）　加熱源であるﾌﾟﾗｽﾞﾏ密度分布
（２）　加熱源であるﾋｰﾀの発熱量の分布
（３）　保持部材表面とｳｴﾊｰ裏面間のＨｅｶﾞｽ圧力分布
（４）　保持部材と冷却部での接触による熱逃げ
（５）　保持部材と冷却室間の冷却ｶﾞｽ圧分布
（６）　冷却室と冷却室固定板間の熱逃げ
（７）　周囲ﾁｬﾝﾊﾞｰ内壁面への熱輻射
（８）　保持部材中の静電ﾁｬｯｸｶﾊﾞｰへの熱逃げ
（９）　冷却路での抜熱量分布

等、非常に多くの影響因子が有り、高温になると、特に温度分布を均一化する事は非常に難しくなる。また、温度制御応答性の点から、制御対象となるｳｴﾊｰ裏面にできるだけ近い位置での制御因子を使用するのが望ましい。

【００３９】以下に本発明の実施例の説明を続ける。図１において、反応室２６壁面からμ波導波管２７で導入する。このμ波２９をμ波透過窓２８より導入し、μ波透過窓２８の回りに配置した永久磁石３０によるＥＣＲ共鳴を利用し、高エネルギー電子を発生させ、ﾉｽﾞﾙﾘﾝｸﾞ３２のﾉｽﾞﾙ３３から供給される処理ｶﾞｽを解離、電離しﾌﾟﾗｽﾞﾏ３４が生成される。反応室２６の天板、側壁に配置した永久磁石３０によりｶｽﾌﾟ磁場３５を形成し、ﾌﾟﾗｽﾞﾏ３４を閉じ込める。

【００４０】保持部と冷却部の接触部での熱絶縁の為、ｱﾙﾐﾅ等の断熱材を鋏み、またＨｅｶﾞｽ圧の分布を均一化する為、Oﾘﾝｸﾞを絶縁物１７ａ、１７ｂを介し固定する。これにより熱逃げ量を最低限に抑えることが出来る。

【００４１】又は、保持部材と冷却部材との接触面積を減らす為に、熱絶縁材を図７に示すようなﾊﾆｶﾑ構造体とすることも可能である。

【００４２】光ﾌｧｲﾊﾞｰ温度計ﾌﾟﾛｰﾌﾞ１６は導入端子ﾌﾗﾝｼﾞ４０を介し、ｺﾝﾄﾛｰﾗ４１Ａ、４１Ｂに接続される。こ

の温度読み値はＨｅｶﾞｽ圧と熱伝達係数αとの関係ﾃﾞｰﾀが入力されたﾌｨｰﾄﾞﾊﾞｯｸ回路４２に入る。次に、上記入力ﾃﾞｰﾀよりＨｅｶﾞｽ圧の増減分ΔＰ１，ΔＰ２がＨｅｶﾞｽ圧力ｺﾝﾄﾛｰﾗ４３に入力され設定Ｈｅｶﾞｽ圧力を変更する。Ｈｅｶﾞｽ圧力ｺﾝﾄﾛｰﾗ４３はﾏｽﾌﾛｰ４４と圧力計４５で構成される。Ｈｅｶﾞｽはｶﾞｽﾎﾞﾝﾍﾞ４７から図示しないﾚｷﾞｭﾚｰﾀ、手動ﾊﾞﾙﾌﾞ４６を介して供給される。温度制御方法について下記により詳しく説明する。

【００４３】例えば、あるﾌﾟﾛｾｽにおいて、熱変形により保持部が凸の形状に変形した場合について考える。この時のﾌﾟﾗｽﾞﾏ入熱、Ｈｅｶﾞｽ室高さＨの変化（中心部）、ｳｴﾊｰ温度変化（中心部）、Ｈｅ圧力の変化を図８に示す。ﾌﾟﾗｽﾞﾏ入熱による熱変形は、図８に示すようにより大きくなる。

【００４４】図9に示すように、Ｈｅｶﾞｽ室高さＨが変化する事で熱伝達係数αは小さくなる為（α１→α２）、ｳｴﾊｰ温度は上昇し、ついには許容範囲外に上昇する。

【００４５】光ﾌｧｲﾊﾞｰ温度計からの測定値と制御したい温度値との比較を図１０のステップ１０２に示すﾌｨｰﾄﾞﾊﾞｯｸ制御で比較演算し、ステップ１０４の比較において測定値が仕様値でない場合、ステップ１０６で図９に示す関係よりＨｅｶﾞｽ圧をP１からP２へ変化させ、ﾏｽﾌﾛｰｺﾝﾄﾛｰﾗに制御したいＨｅｶﾞｽ圧設定値を入力する。

【００４６】これにより、ｳｴﾊｰ温度は図８に示すように変化する。上記構成によりｳｴﾊｰ中心部温度は、ある許容範囲内に温度制御する事が可能になる。ｳｴﾊｰ外周部でも同様に温度を独立して制御する。

【００４７】図１１に、上記実施例に示す半導体処理装置によりｳｴﾊｰ１にﾌﾟﾗｽﾞﾏＣＶＤによる成膜処理をする場合の、処理手順の一例を示す。図１１は、ﾋｰﾀ出力Q１、保持部材～冷却部材間のｶﾞｽ圧力（中心部）Ｐ１、保持部材～冷却部材間のｶﾞｽ圧力（外周部）Ｐ２、ｳｴﾊｰ～保持部材間のｶﾞｽ圧力P３、ﾌﾟﾗｽﾞﾏ入熱Q２、保持部材の表面温度T１、ｳｴﾊｰ温度T２の時間変化を示す。各々のｸﾞﾗﾌの横軸は、時間を示している。横軸で同じ位置に有れば同じ時間を示している。

【００４８】（ａ）ｳｴﾊｰ１枚目のﾌﾟﾗｽﾞﾏ処理前

t0～t1間でP1、P2を０近傍の圧力値にする。ｔ１で保持部材２のﾋｰﾀ８に通電する事で、Ｑ１の発熱を生じ、保持部材が加熱される。この時、P1、P2は、各々０近傍の為、熱絶縁になっており、冷却部材に熱が逃げないため、ﾋｰﾀにより効率的に、所望の温度まで、最短時間で昇温できる。ｔ２でｳｴﾊｰを真空ﾛﾎﾞｯﾄ等で保持部材２の直上に移動させ、図示していないｳｴﾊｰ昇降ﾋﾟﾝによって、ｳｴﾊｰ１を保持部材２の上に載せる。次に吸着電極７にﾌﾟﾗｽ、またはﾏｲﾅｽの電圧を印可し、ｳｴﾊｰ１を吸着する。ｔ３でｳｴﾊｰ～保持部材間のｶﾞｽ室にｶﾞｽをある圧力を保ち、導入する。ｔ２～ｔ３では、ｳｴﾊｰは、加熱された保持部材と接触熱伝達で昇温し、t3でｶﾞｽ熱伝達で、昇温する。ｶﾞｽ熱伝達の場合、接触熱伝達と比較して、伝熱効果が著しく増加する為、ｳｴﾊｰ温度変化は大きく、短い時間で昇温する。ｔ４にてﾋｰﾀの出力を小さくし、０にする。これにつれて保持部材の表面温度T１、ｳｴﾊｰ温度T２は、図１１に示すように低くなる。

【００４９】（ｂ）ｳｴﾊｰ１枚目のﾌﾟﾗｽﾞﾏ処理

ｔ５にﾌﾟﾗｽﾞﾏ点火する。図１１には、ｳｴﾊｰ１への入熱量が中心部で外周部と比較して大きい場合を示している。ｳｴﾊｰの表面の各部位での温度を一定に保つ為、各伝熱ｶﾞｽ室において、図８に示すようにｶﾞｽ圧力を変化させる。この場合、ｳｴﾊｰの中心部に比較し、外周部のｶﾞｽ圧力を低くし、ｶﾞｽによる熱伝達係数を低下させ、ｳｴﾊｰ１の温度を外周部で、中心部と比較して、温度上昇値を大きくし、ｳｴﾊｰ面上での温度を高くし、ﾌﾟﾗｽﾞﾏ入熱時のｳｴﾊｰ面内の温度分布の均一性を向上させる。逆に、外周部が中心部と比較して入熱量が大きい場合には、ｶﾞｽ圧力の関係を逆にする。ﾌﾟﾗｽﾞﾏ点火後、成膜ｶﾞｽを処理室内に導入し、化学反応により、ｳｴﾊｰ１面上に酸化石英の薄膜を形成させる。ｔ６にﾌﾟﾗｽﾞﾏを消滅させる。これは、μ波ﾊﾟﾜｰ、ＲＦﾊﾟﾜｰ、成膜ｶﾞｽの導入を停止させる事で行う。これにより、ﾌﾟﾗｽﾞﾏ入熱Q2は、図１１に示すように減少し、これにつれて、Ｐ１、Ｐ２、Ｐ３を減少させ、０とする。ｔ７にｳｴﾊｰを図示しないｳｴﾊｰ昇降ﾋﾟﾝにより、ｳｴﾊｰを持ち上げ、真空ﾛﾎﾞｯﾄにより、処理室からｳｴﾊｰ１を搬出する。

【００５０】（Ｃ）ｳｴﾊｰ２枚目のﾌﾟﾗｽﾞﾏ処理前

ｔ７～ｔ１'間に上記と同じ方法でｳｴﾊｰ１を搬入する。ｳｴﾊｰ一枚目の処理と異なり、ﾋｰﾀ出力Ｑ１'は既にある一定温度まで昇温されているので、Ｑ１より小さな値で十分である。

【００５１】（ｄ）ｳｴﾊｰ２枚目のﾌﾟﾗｽﾞﾏ処理

一枚目と同様であるので説明を省略する。

【００５２】上記は、ｳｴﾊｰ１～保持部材２間のｶﾞｽ圧力をｳｴﾊｰ１によって形成される２ヶ所以上の各ｶﾞｽ室を同じ圧力で制御しているが、保持部材～冷却部材間のｶﾞｽ圧力を各ｶﾞｽ室毎に一定（中心部、外周部でｶﾞｽ圧力を一定とする。）にし、ｳｴﾊｰ～保持部材間のｶﾞｽ圧力を 各ｶﾞｽ室毎に変化させても同じ効果が得られる。また、図１１に示すｶﾞｽ圧力Ｐ１、Ｐ２、Ｐ３ではなく、中心部、外周部のﾋｰﾀ８の発熱量を、各部位からのｳｴﾊｰ温度をﾌｨｰﾄﾞﾊﾞｯｸして、発熱量を変化させても同じ効果を得られる。また、上記と同じ効果は、冷却媒体１０の温度、流量を変化させても得られる。

【００５３】冷却媒体１０の温度で、冷却部材３の温度分布を直接ｺﾝﾄﾛｰﾙでき、又、冷却流量で冷却効果を変化でき、冷却流路での膜温度を変化させれるので、同じく冷却部材での温度分布を同じく変化させ事が可能になる。

【００５４】結局、ｶﾞｽ圧力Ｐ１、Ｐ２、Ｐ３が一定でも、上記と同じくｳｴﾊｰ温度分布をある一定値内に制御す

る事が可能になる。但し、制御の応答性から考えると、ｳｴﾊｰ１と保持部材２のｶﾞｽ圧力を各部位毎に変化させた場合が一番制御速度が早く、制御性が良い。

【００５５】図１１に示すＱ１、Ｐ１、Ｐ２、Ｐ３、Ｑ２等は図１１では、ある一定時間後に、おいて一定値となっているが、各時間毎に変化させても良い。特に、Ｐ１、Ｐ２は、ﾌﾟﾗｽﾞﾏ入熱が時々刻々変化する一般的な入熱ﾊﾟﾀｰﾝにおいては、変化させるのが、良い。

【００５６】また、図１１では、ｶﾞｽ圧力Ｐ１、Ｐ２の昇圧開始をﾋｰﾀ出力が0になってからとなっているが、ﾋｰﾀがＯＮ時から行っても良い。ｶﾞｽ圧力P３をﾋｰﾀ出力が0FFとなってから行っても良い。

【００５７】図１１は、一例を示すものであり、ここでは一々、記載しないが、種々の変形がある。

【００５８】図１２に本発明の別の実施例を示す。図１との差異は保持部材２とｳｴﾊｰ１間のＨｅｶﾞｽ圧を中心部、外周部またはそれ以上の独立した部位（複数の伝熱ｶﾞｽ室）に分け、図示していない伝熱ｶﾞｽの経路を保持部材２の内部に形成して各伝熱ｶﾞｽ室に連通させ、ｳｴﾊｰ裏面の中心部と外周部におけるＨｅｶﾞｽ圧を変化させるものである。ｶﾞｽ室の部位の分離は静電ﾁｬｯｸ表面の凹、凸（溝）で形成する。

【００５９】この構造図を図１３に示す。図１３に示すように、保持部材２の中間部に土手部２００を形成し、吸着電極７bを土手部２００の下に配置し、他の吸着電極７aとは独立させ、他の吸着電極より大きなﾊﾞｲｱｽ電圧を印加し、ｳｴﾊｰを吸着し、各部位間のＨｅｶﾞｽﾘｰｸ量を低減させている。図１３では土手部２００により静電ﾁｬｯｸ表面の室を２個所のみに分離したが、これは何個所あっても良い。又、土手部に小さな幅のｽﾘｯﾄを設けても良い。但し、ｽﾘｯﾄ幅はｳｴﾊｰ等の処理物を載せて形成される各部位（伝熱ｶﾞｽ室）毎に圧力を独立に制御できる程度の小さなものとする。

【００６０】ここで、上記、ｳｴﾊｰ１と保持部材２の表面の空間に伝熱ｶﾞｽ室を２ヶ所以上、設けるﾊﾟﾀｰﾝをＡとし、保持部材２と冷却部材３との空間に伝熱ｶﾞｽ室を２ヶ所以上、設けるﾊﾟﾀｰﾝをＢとする。

【００６１】温度均一性を向上させてｳｴﾊｰ１を処理する為には、少なくとも上記、ﾊﾟﾀｰﾝＡ、Ｂのいずれか一方を採用すれば良い。ﾊﾟﾀｰﾝＡ，Ｂの両方を採用した場合には、制御対象となる検出温度が多くなる為、制御が難しい等の問題が発生する場合があり、ﾊﾟﾀｰﾝＡまたはＢのみ採用する事が望ましい。

【００６２】図１４に本発明の別の実施例を示す。図１との相違はｳｴﾊｰの温度制御にﾋｰﾀの発熱量を部位毎に変化させるものである。例えば、図１４では中心部ﾋｰﾀ８b、外周部のﾋｰﾀ８aで形成する。切り替えｽｲｯﾁ５７により高周波印加時にﾋｰﾀ８a、８bを切るものである。ｳｴﾊｰ裏面を測温する測温ｺﾝﾄﾛｰﾗ４１の指示値と目標値との差異をﾌｨｰﾄﾞﾊﾞｯｸ回路４２で検知しﾋｰﾀの電力調整器５６A，５６Bの設定値を変更する。

【００６３】図１５に本発明の別の実施例を示す。図１との相違はｳｴﾊｰの温度制御に冷却水の温度、流量を部位毎に変化させるものである。図１５では中心部、外周部の冷却水路で形成するものである。測温ｺﾝﾄﾛｰﾗ４１の指示値と目標値との差異をﾌｨｰﾄﾞﾊﾞｯｸ回路４２で検知し、冷却と加熱機能を有するﾁﾗｰ５８の冷却水の温度設定値、流量を変更する。流量を変化させ、冷却流路の壁面での熱伝達係数αを変化させ、壁面での温度差を制御するものである。但し、ﾁﾗｰ内の冷却媒体の熱容量が大きいため、ﾋｰﾀを使用したものに比べて応答性は悪い。

【００６４】

【発明の効果】本発明によれば、試料を高温で温度分布の均一性を保ち、ﾌﾟﾗｽﾞﾏ処理する事が可能となり、高品質な処理済試料を提供できる

【図面の簡単な説明】

【図１】本発明の第１実施例を示す半導体処理装置の側断面図である。

【図２】図１の実施例における保持部材と冷却部材の各平面図である。

【図３】Ｈｅｶﾞｽ圧力と熱伝達係数との関係を示す図である。

【図４】ﾌﾟﾗｽﾞﾏ入熱時の保持部材の変形を示す図である。

【図５】Ｈｅｶﾞｽ層の厚みが変化した場合のＨｅｶﾞｽ圧力と熱伝達係数との関係を示す図である。

【図６】保持部材の熱変形によるｳｴﾊｰ温度上昇分布を示す図である。

【図７】保持部材と冷却部材との間に挟む絶縁物の構造を示す図である。

【図８】ﾌﾟﾗｽﾞﾏ処理時の保持部材の変形と温度変化を示す図である。

【図９】Ｈｅｶﾞｽ層の厚みが変化した場合のＨｅｶﾞｽ圧力と熱伝達係数との関係を示す図である

【図１０】温度制御ﾌﾛｰを示す図である。

【図１１】本発明の第１の実施例に示す半導体処理装置の、処理ﾌﾛｰの例を示すﾁｬｰﾄ図である。

【図１２】本発明の第２実施例を示す半導体処理装置の側断面図である。

【図１３】静電ﾁｬｯｸ部の側断面を示す図である。

【図１４】本発明の第３実施例を示す半導体処理装置の側断面図である。

【図１５】本発明の第４実施例を示す半導体処理装置の側断面図である。

【図１６】ｳｴﾊｰ温度と膜質との関係を示す図である。

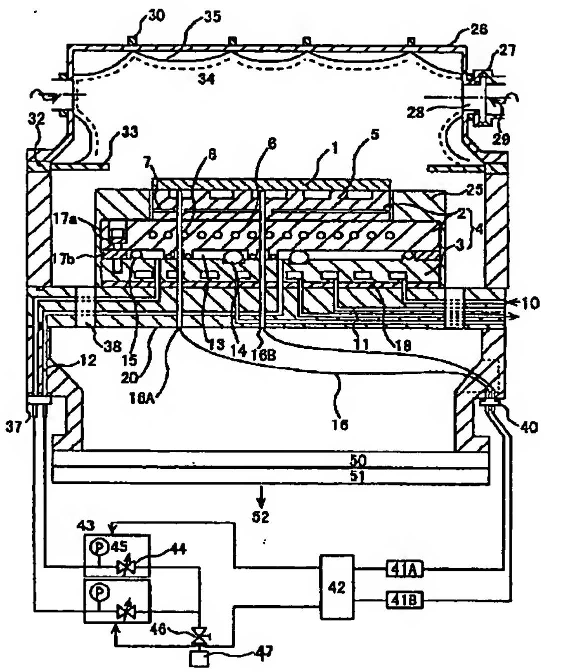
【符号の説明】

１…ｳｴﾊｰ 、２…保持部材、３…冷却部材、４…高温用吸着装置、５…静電ﾁｬｯｸ部材、６…静電ﾁｬｯｸ部材支持板、７a，７b…吸着電極、８a…外周ﾋｰﾀ、８b…中心部ﾋｰﾀ、１０…冷却媒体、１１…冷却流路、１２…Ｈｅｶﾞｽ流

路、１３…Ｈｅｶﾞｽ室、１４…Oﾘﾝｸﾞ、１０～１５…Oﾘﾝｸﾞ、１６…光ﾌｧｲﾊﾞｰ温度計ﾌﾟﾛｰﾌﾞ、１７ａ、ｂ…絶縁物、１８…絶縁物、２０…高温用静電吸着装置支持板、２１…絶縁物、２６…反応室、２７…μ波導波管、２８…μ波透過窓、２９…μ波、永久磁石、３２…ﾉｽﾞﾙﾘﾝｸﾞ、３３…ﾉｽﾞﾙ、３４…ﾌﾟﾗｽﾞﾏ、３５…ｶｽﾌﾟ磁場、３６…磁力線、３７…ﾌﾗﾝｼﾞ、３８…排気穴、４０…端子導入ﾌﾗﾝｼﾞ、４１…測温ｺﾝﾄﾛｰﾗ、４２…ﾌｨｰﾄﾞﾊﾞｯｸ回路、４３…圧力ｺﾝﾄﾛｰﾗ、４４…ﾏｽﾌﾛｰ、４５…圧力計、４６…手動ﾊﾞﾙﾌﾞ、４７…冷却用ｶﾞｽ、５０…ﾒｲﾝﾊﾞﾙﾌﾞ、５１…ﾀｰﾎﾞ分子ﾎﾟﾝﾌﾟ、５２…ﾄﾞﾗｲﾎﾟﾝﾌﾟ、５５…ﾌﾟﾗｽﾞﾏ入熱、５６…電力調整器、５７…ｽｲｯﾁ、５８…ﾁﾗｰ

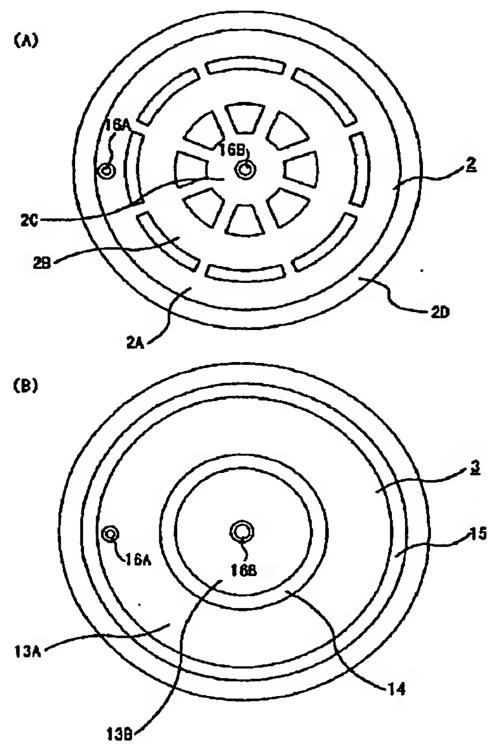
【図１】

図　1



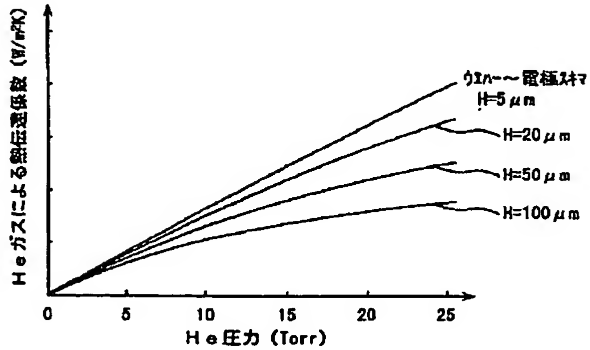
【図２】

図　2



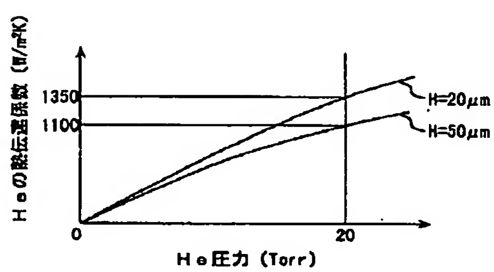
【図３】

図　3



【図５】

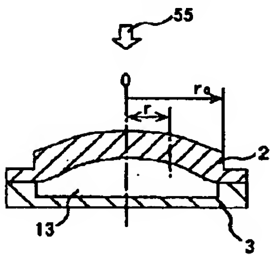
図　5



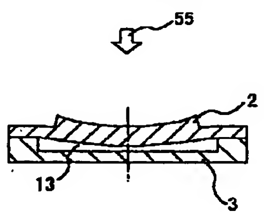
【図４】

図　4

(i)　凸型



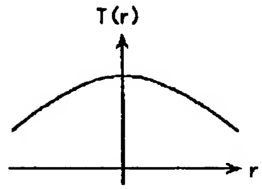
(ii)　凹型



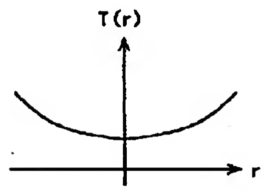
【図６】

図　6

(i)　凸型

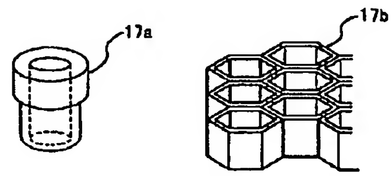


(ii)　凹型



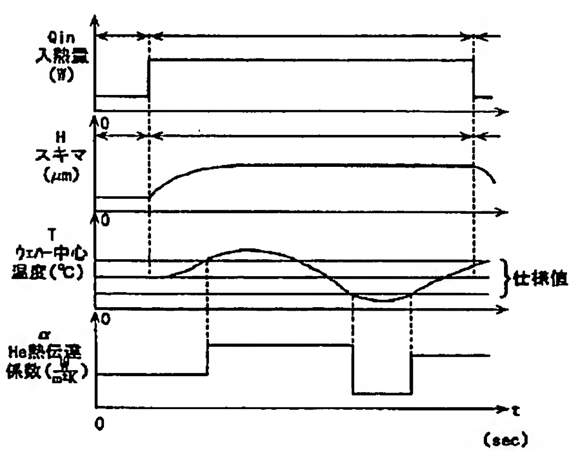
【図７】

図　7



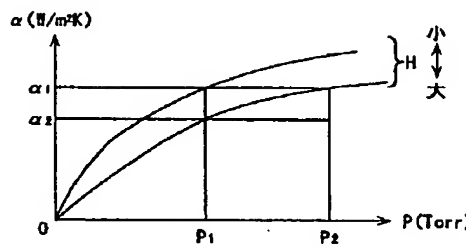
【図８】

図　8



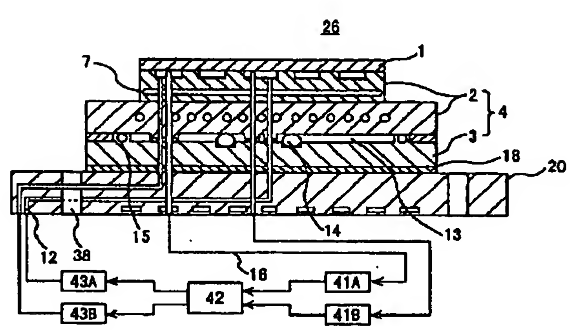
【図９】

図　9



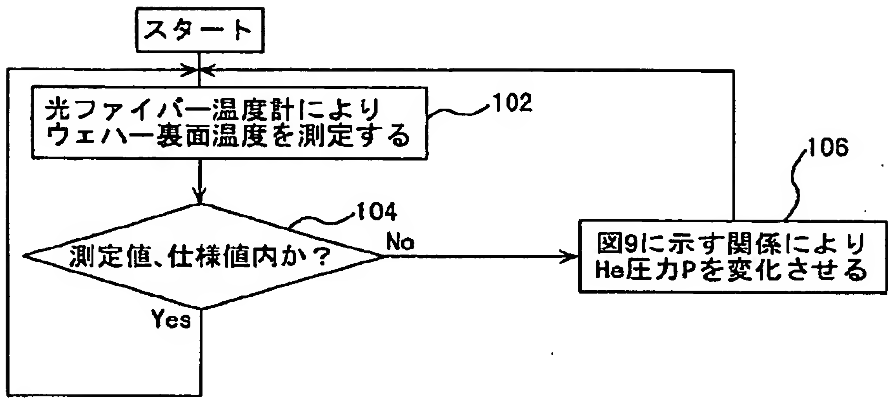
【図１２】

図　12

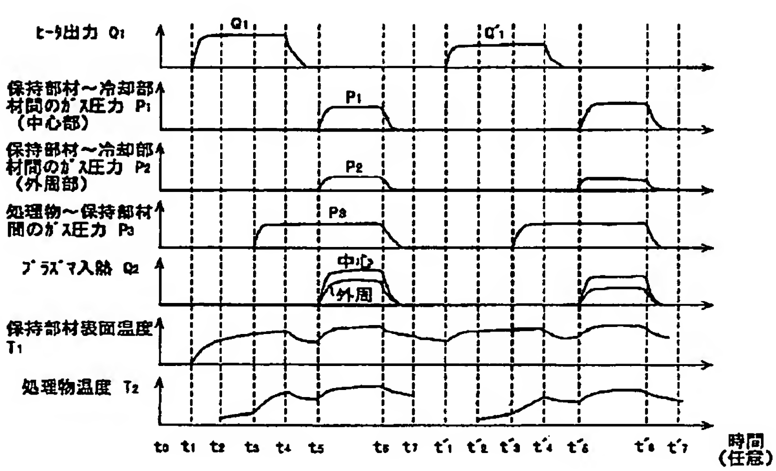


【図１０】

図 10

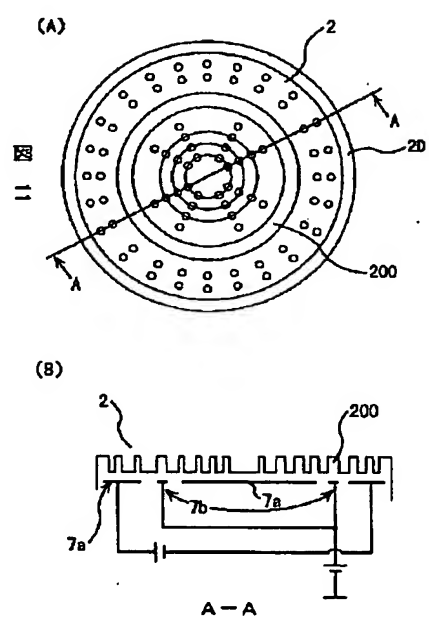


【図１１】



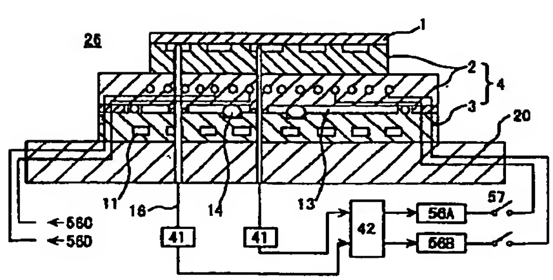
【図１３】

図 13



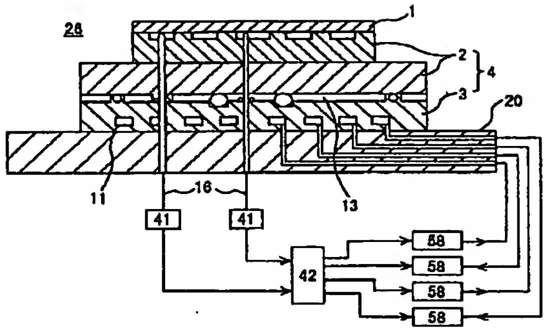
【図１４】

図 14



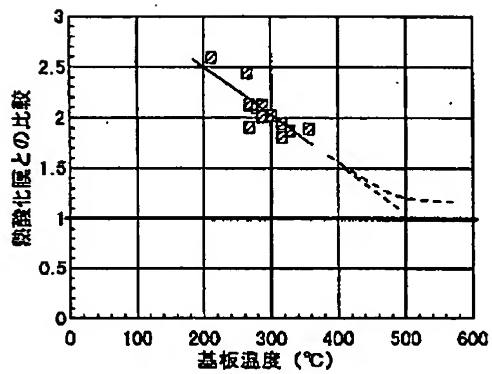
【図１５】

図 15



【図１６】

図 16



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